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Teaching Thinking Skills in the Content Area: A Workshop for Secondary School Teachers

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TEACHING THINKING SKILLS IN THE CONTENT AREA:

A WORKSHOP FOR SECONDARY SCHOOL TEACHERS

A Thesis Presented

by

Evelyn Ryan

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ABSTRACT

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A WORKSHOP FOR SECONDARY SCHOOL TEACHERS

DECEMBER, 1994

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This thesis presents a curriculum for a workshop on teaching thinking skills in the content area designed for secondary school teachers. In-service time for the workshop is twenty hours. The first fifteen hours are scheduled for one week in the summer. Two follow-up sessions, each two and a half hours in length, are scheduled during the school year.

The purpose of this curriculum is to establish a foundation for skillful thinking--purposeful thought that is aware not only of its objectives but of its own processes. In order to accomplish this purpose the workshop has two goals. The first goal is to teach the method of direct instruction in teaching thinking skills developed by Barry K. Beyer. The second goal is to model active learning strategies that support skillful thinking in the secondary school classroom.

The method of direct instruction features the following procedure for teaching thinking skills in the content area:

- Determine what you want your students to be able to do better.
- Note places where this activity occurs in a particular course.
- Identify the key thinking skill involved in the activity.
- Describe that thinking skill.
- Plan a sequence of skill teaching lessons.
- Write the lessons using appropriate skill teaching strategies.
- Determine your assessment strategy and write the necessary evaluation instruments.
- Teach the thinking skill.
- Repeat this process for one or two other thinking skills that are critical to learning your subject matter.

Active learning strategies that support skillful thinking include the following:

- Creating a classroom atmosphere that fosters positive attitudes about thinking and its teaching.
- Using several cooperative learning activities to teach the workshop's content.
- Guiding instruction in metacognition.
- Leading discussions using techniques that facilitate skillful thinking.
- Assessing the learning in the workshop with a final project that requires the participants to synthesize and apply their knowledge.

This workshop thus provides a practical way for teachers to begin the complex but rewarding task of teaching thinking in their classrooms.

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CHAPTER I

THE INCEPTION OF THE WORKSHOP

"What's the matter with these kids? Don't they know how to think?"

The workshop described on the following pages is designed for any secondary school teacher who has caught himself uttering these words. They are words of exasperation. Clutching a sheaf of disappointing papers in my hands, I have shouted them myself.

You present a challenging exercise and your students just don't respond. What do you do? Do you reteach the material? Something inside says that won't do the trick. The problem is not with the material. The problem is with comprehension, analysis, synthesis, evaluation--the problem is with higher order thinking. How can we teach our students to do the thinking needed to extend their learning of our subject matter?

My own subject matter is high school mathematics. I set out to answer this question when I was discouraged by my students' performance on word problems. Performance? I should say lack of performance. I was particularly displeased with an algebra course for students of average abilities. It was clear that the students understood the algebraic algorithms. They could simplify and solve the necessary equations and inequalities. But faced with a word problem that applied this knowledge, they were confounded. They simply did not know what to do.

My search led me to Barry Beyer's Practical Strategies for the Teaching of Thinking. Beyer recommends a general method for teaching thinking skills in any content area. I adapted his method to teach problem solving in my algebra course.

Beyer's method obliged me to make a fundamental change in my teaching. It required me to focus on problem solving as a skill. This meant temporarily shifting my focus of instruction from subject matter to thinking skills. In order to teach the skill of problem solving, I had to know it in detail. I had to search my own understanding of problem solving as I had never done before. I had to extend my understanding with research on problem solving. In the process I learned a great deal about mathematical problem solving. Beyer supplemented this learning with information on thinking skills teaching. This combination of knowledge enabled me to create lessons and instructional materials to help my students really understand how to solve word problems.

I designed a problem solving unit according to Barry Beyer's recommendations. When I implemented the unit, it was a success. Students who once left word problems blank began to tackle them. With practice they began to solve them. Success with these problems has bred confidence and my students' attitudes have improved. Instead of dreading word problems, they now look forward to them. They take pride in detailing any strategies they discover. The word problems they write themselves not only show

understanding but also delight me with their imagination and humor. My classroom is a better place because of this intervention.

The method that Beyer recommends is not confined to teaching mathematical problem solving. It can be used to teach the thinking skills required in any content area. The workshop described here is designed for all secondary school teachers interested in a practical way to begin to improve the quality of the thinking done by all of their students, regardless of ability level.

In-service time for the workshop is twenty hours. The first fifteen hours are scheduled for one week in the summer. There are five sessions in this week, each of three hours' duration. Two follow-up sessions are scheduled during the school year to provide support. Each is two and a half hours in length.

The primary goal of this workshop is to prepare secondary school teachers to teach thinking skills in their content areas. This goal is accomplished by teaching the following step-by-step procedure:

- Determine what you want your students to be able to do better.
- Note places where this activity occurs in a particular course.
- Identify the key thinking skill involved in the activity.
- Describe that thinking skill.
- Plan a sequence of skill teaching lessons:
    - Introduction
    - Guided practice
    - Independent application
    - Transfer and/or elaboration
    - Guided practice

- Independent application
- Autonomous use

• Write the lessons using appropriate skill teaching strategies.

• Determine your assessment strategy and write the necessary evaluation instruments.

• Teach the thinking skill.

• Repeat this process for one or two other thinking skills that are critical to learning your subject matter.

In order to learn this procedure the workshop participants take part in daily activities centered around one or two components of the procedure. These components are selecting a thinking skill, writing a description of that thinking skill, sequencing the appropriate lessons, designing the lesson plans and developing the necessary assessment instruments. Using these components, each participant gradually develops a unit plan for teaching one thinking skill in a particular course in his academic discipline.

This workshop can help teachers get started in teaching thinking in their classrooms, but it cannot come close to providing them all they need to know. It can be no more than introductory in nature. Therefore the workshop curriculum upholds the following three goals:

• To clearly indicate to the workshop participants that further study is necessary.

• To advise the workshop participants as to additional resources and programs available to them.

• To motivate these workshop participants to continue their own studies in the areas of thinking and the teaching of thinking, and to advocate for the teaching of thinking.

The secondary goal of this workshop is to have the participants experience instructional strategies that support higher order thinking in the classroom. This goal is accomplished through the workshop's attention to the following elements of instructional design:

- Creating a classroom atmosphere that fosters positive attitudes about thinking and its teaching.
- Using a variety of cooperative learning activities to teach the workshop's content.
- Guiding instruction in metacognition.
- Leading discussions using techniques that facilitate higher order thinking.
- Assessing the learning in the workshop with a final project that requires the participants to synthesize and apply their knowledge.

The purpose of this curriculum is to establish a foundation for skillful thinking--purposeful thought that is aware not only of its goals but of its own processes. Thinking can be conceptualized as having three major components: cognitive operations, knowledge and dispositions (Beyer 1987). The focus of the workshop is on the first of these, the cognitive operations, also known as thinking skills. Thinking skills are the various strategies we use to make sense of information. Research has shown that when students are taught the specific thinking skills necessary to learn some particular academic subject matter, their achievement in that subject matter improves (Beyer 1991). Teachers can therefore improve student performance in an academic subject by teaching the requisite thinking skills.

It is my hope that the participants will experience this workshop as a beginning. Although the workshop provides a foundation for teaching skillful thinking, there is far more to that objective than teaching thinking skills. Thinking skills are only one facet of a very complex phenomenon. As noted earlier, thinking can be conceptualized as having three key components: cognitive operations, knowledge and dispositions. Improvements in all of these can be made with attention to classroom atmosphere, instructional materials and methods that foster active learning and metacognition, alternative assessments and sensitivity to individual learning styles. Incorporating any of these into the classroom demands that teachers change the way they teach. This is not easily done, since most teachers have no experience of these practices. These interventions were not in use when the teachers learned their subject matter, nor were they taught to the teachers in their pre-service training.

It is beyond the scope of this workshop to instruct the participants in all of these changes. However, the workshop will serve as a model for the teachers. The instructional design of the workshop will involve them in alternative learning experiences that would be appropriate in their classrooms. It is hoped that the participants will enjoy these experiences and will learn to build on the innovations in their own classrooms. It is desired that the participants will be motivated to seek further instruction in skillful thinking, such as that offered in the Critical and Creative Thinking Program at the University of Massachusetts Boston.

CHAPTER II

A RATIONALE FOR THE WORKSHOP

The curriculum for the workshop is based on four principles which fall into two categories of beliefs. The first category reflects my beliefs about the teaching of thinking in general. I believe that skillful thinking should be a major goal of education. I also believe that, at the secondary level, skillful thinking should be taught in the content areas. The first of these beliefs encouraged me to design this workshop; the second convinced me that secondary school teachers would benefit from taking part in it.

The second category concerns issues of staff development that are relevant to initiating the teaching of skillful thinking. I believe that the method of direct instruction in thinking skills is a good place for teachers to begin this complex task. I also believe that teachers need to experience the instructional innovations that support skillful thinking in the classroom. The first of these beliefs informed the content selected for the workshop; the second determined the instructional strategies to be employed.

The rationale for each of these four principles is discussed below with reference to how each relates to the instructional design of the workshop curriculum.

Skillful Thinking Should be a Major Goal of Education

There is no shortage of national reports from both the world of work and the field of education urging the necessity for teaching skillful thinking. The frequency with which Americans are often forced to change jobs, an increasingly global economy and the technology that makes an abundance of information overwhelmingly accessible to us make urgent demands on every citizen's abilities to think skillfully (Paul 1987, 1-6). Moreover, as A Nation at Risk warned in 1983, America's edge in commerce, industry, science and technology has been lost to other countries (Thomas 1992, 1).

Improvement in our thinking is clearly indicated as part of the plan for meeting these challenges. In 1992 the Secretary's Commission on Achieving Necessary Skills (SCANS) of the U.S. Department of Labor prepared a report for America 2000 to describe the "high performance workplace", an ideal for American industry. "Know-how" for this workplace is identified in this report in terms of five competencies and three foundational skills. In the foundational skills, "thinking skills" appear, defined thus: "the ability to learn, to reason, to think creatively, to make decisions, and to solve problems" (6). These skills are considered necessary, not solely in management, but for every worker. The emphasis on thinking skills is echoed by the Education Commission of the States' Task Force on Economic Growth (1983), by the Rockerfeller Commission on the Humanities (1980) and by Ernest Boyer of the Carnagie Foundation (1983).

Nationally administered standardized tests produce evidence of students' lack of skillful thinking. showing that students experience persistent difficulty in solving problems, writing persuasively and interpreting what they read (McTighe and Clemson 1991, 304-305). The National Assessment of Educational Progress administered throughout the last decade showed that American students do poorly on tests involving reasoning about course content (Quellmalz 1991, 340; Applebee et al. 1991, 17).

The gloomy perception expressed in A Nation at Risk, that "our educational foundations are being eroded by a rising tide of mediocrity," probably strikes a dark chord of recognition in the heart of every educator. But is that enough to persuade educators that by teaching thinking skills they will be able to turn this tide? These reports provide ample negative motivation for the teaching of thinking, but what about positive motivation? What can the teachers hope to gain?

If classroom teachers are to be persuaded that they must teach thinking, they will have to clearly see the connection between teaching thinking and improved student performance in their subject matter. It was this connection that encouraged my own teaching of thinking in my mathematics classes. Teachers have to ask themselves where they want to see improvements in their students' performance. Then they must focus on the thinking necessary to bring about these improvements. Teaching the necessary thinking skills effectively will enhance student learning of subject matter content.

It is very likely that most teachers have never approached the problem of poor student performance from a thinking skills perspective. Therefore a major goal of the workshop is to very clearly indicate the connection between teaching thinking skills and improved subject matter learning.

Beyond its specific goals, this workshop hopes to instill in the teachers the dispositions, attitudes and inclinations that are characteristic of intelligently behaving human beings and good thinkers (Costa 1991c). Raymond Nickerson describes the ideal good thinker as follows (1987, 24-26). A good thinker:

- uses evidence skillfully and impartially;
- organizes thoughts and articulates them concisely and coherently;
- distinguishes between logically valid and invalid inferences;
- suspends judgment in the absence of sufficient evidence to support a decision;
- understands the difference between reasoning and rationalizing;
- attempts to anticipate the probable consequences of alternative actions before choosing among them;
- understands the idea of degrees of belief;
- has a sense of the value and cost of information, knows how to seek information and does so when it makes sense;
- sees similarities and analogies that are not superficially apparent;
- can learn independently and, at least equally importantly, has an abiding interest in doing so;

- can structure informally represented problems in such a way that formal techniques can be used to solve them;
- listens carefully to other people's ideas;
- understands the difference between winning an argument and being right;
- recognizes that most real world problems have more than one solution;
- looks for unusual approaches to complex problems;
- can strip a verbal argument of irrelevancies and phrase it in terms of its essentials;
- understands the differences among conclusions, assumptions and hypotheses;
- habitually questions his own views;
- is sensitive to the difference between the validity of a belief and the intensity with which it is held;
- can represent different viewpoints without distortion;
- is aware of the fact that one's understanding is always limited;
- recognizes the fallibility of his own opinions.

The good thinker, according to Nickerson, performs expertly a wide range of tasks that engage several specific thinking skills. Thinking of this caliber requires rigorous training. Good thinking is analogous to good posture. It does not happen automatically. Just as most people have a tendency to slouch, most people also have an inclination toward sloppy thinking. Notice, for example, how easily we are duped and how often we interpret evidence in the light of our personal biases (Nickerson 1987, 28). Just as the habit of good posture can be trained and eventually become

automatic, so can habits of good thinking. The training is a gradual process that requires a great deal of time and careful attention. Barbara Presseisen (1991, 56) argues that such training must take place throughout one's education. Young learners should develop confidence in using basic thinking skills in their early years. The complexities of these skills should gradually unfold in closely related subject matter throughout the middle school and high school years. Such long-term training requires a serious system-wide commitment by educational professionals. The end product is well worth the effort. As Nickerson points out, good thinking is at the heart of what it means to be fully human (32). Therefore good thinking, which I define as skillful thinking, should be a major goal of education.

Making skillful thinking a major goal of education is beyond the scope of this workshop. Making secondary school teachers aware of the importance of this goal is a major step towards its attainment. That awareness is a primary objective of the curriculum. The workshop participants will read and discuss Nickerson's description of a good thinker. The experience is meant to be unsettling. Some questions raised by this description include: How closely do our students resemble this ideal? How close do we ourselves come? The dissatisfaction the teachers might feel with their answers should arouse their desires to learn, not only how to help students become better thinkers, but also how to improve their own thinking abilities.

Skillful Thinking Should be Taught in the Content Areas

The design of any curriculum for teaching thinking requires an initial decision as to whether the content should be taught in a stand-alone course or integrated into the traditional subject matter courses as an additional objective. Two primary goals in teaching thinking are to improve our students' academic learning and to contribute to their life skills. Sternberg argues that, for teaching thinking, it does not matter so much whether we choose a stand-alone curriculum or an integrated one, so long as we keep these goals in mind and implement them one way or the other (1987b, 456-459). Although I agree with Sternberg to some degree, I have some practical concerns that make me favor an integrated curriculum at the secondary level.

A stand-alone course seems to have the advantage of convenience. Such a course can be taught by a specialist, or a small group of specialists, trained in the teaching of thinking. Unfortunately, as Robert Swartz points out, the transfer of thinking skills acquired in stand-alone courses is far from automatic. The learning may never be put to use in either academic work or in everyday life (1991, 177). Even if it were possible to overcome this difficulty, there is another problem that challenges the apparent convenience of stand-alone courses. The schedules of most secondary school students are already full. Many students who would benefit from courses in thinking would be too busy with other academic requirements to take such courses.

Numerous experts advocate the teaching of thinking in the content areas. There are several advantages of this approach. The most favorable opportunity for teaching any thinking skill is when the need for that skill arises for students in the process of learning subject matter (Glatthorn and Baron 1991, 66-67). All thinking requires content, and the content taught in traditional courses is what our society considers valuable to think about (Swartz 1991, 177-178). Moreover any thinking skill acquires different nuances according to the context in which it is applied (Prawat 1991, 185-186). For instance analyzing a poem and analyzing a chemical compound both involve breaking something down into component parts, but in different ways and for different purposes. Most important of all, the teaching of thinking is not an end in itself, but a means to the end of developing student understanding (Prawat 1991, 187). Teaching thinking promotes a deeper understanding of any subject matter to which the thinking is applied (McTighe and Clemson 1991, 309). Therefore it is important to recognize a compelling symbiotic relationship between thinking skills and content. When subject matter is used to teach thinking skills, those thinking skills improve the learning of the subject matter (Beyer 1991, 7).

The Method of Direct Instruction in Thinking Skills is a Good Place for Teachers to Begin the Complex Task of Teaching Skillful Thinking

Many teachers are skeptical when it comes to the teaching of thinking. Can we teach thinking, they wonder, or is thinking just an innate ability that all humans possess in varying degrees?

David Perkins sheds a great deal of light on that question with his description of intelligence. According to Perkins, intelligence has three dimensions: power, tactics and content. The power is the basic efficacy of an individual's brain. The tactics are the strategies one calls into play when faced with tasks that demand thought. The content is one's knowledge of the field in which one's thinking is operative at any given time (1987b).

In considering how intelligence can be increased, Perkins notes the following. There is a great deal of controversy as to whether an individual's power can or cannot be improved with instruction. Moreover, expertise in any content takes at least ten years to acquire. However, careful instruction in tactics can improve an individual's proficiency. Therefore Perkins recommends teaching for tactics because teaching for tactics can serve to increase intelligence (1987b). What Perkins calls tactics can also be called thinking skills.

Perkins is swift to urge caution in devising or selecting a program for teaching thinking skills. He issues the following warnings and advice (1987b):

- Beware of approaches that rely mostly on experiences or immersion in content to enhance thinking.

- Initial practice of a thinking skill should be on trivial examples, so that the complexity of the task does not overshadow the skill itself. As time goes on, the learners can be gradually weaned from dependency on external reminders of the skill's procedure.

- The program should teach for transfer.

- The program should teach metacognition.

- A comprehensive program should involve many different thinking skills.

- Efforts to develop thinking should either teach the skills directly or do something beyond enrichment in general and modeling in particular to provoke students to invent their own thinking strategies.

The workshop curriculum reflects all seven of Perkins' recommendations in ways that are detailed below.

Beware of approaches that rely mostly on experiences or immersion in content to enhance thinking. These cautions are extended to the workshop participants in the first session. Research has shown that, in order to teach thinking in their classrooms, most teachers provide exercises that require higher order thinking. If their students are unable to perform these exercises, most teachers do not know how to address this problem effectively. Providing challenging exercises is not sufficient in itself for teaching thinking. Students must be taught how to perform the thinking needed to meet the challenges of the learning tasks (Beyer 1987).

Initial practice of a thinking skill should be on trivial examples, so that the complexity of the task does not overshadow the skill itself. As time goes

on, the learners can be gradually weaned from dependency on external reminders of the skill's procedure. The sequence of lessons for teaching a thinking skill that the workshop participants learn supports this objective. The initial focus of the lessons is on the thinking skill. As the sequence progresses, this focus gradually shifts. By the end of the sequence, the skill is internalized and the focus is on significant subject matter learning.

For example, in order to teach the skill of mathematical problem solving, I use a graphic organizer, the *Problem Solving Worksheet.* (See Appendix A, 100.) The instructions on this worksheet guide students through the process of solving a word problem. The students begin their training with very straightforward word problems. With repeated use of the worksheet, the students gradually internalize the problem solving procedure. After a few weeks of lessons centered on problem solving, most students find that they do not need the worksheet to remind them of the steps involved. The abandonment of this worksheet serves as my cue that the students are ready to begin work with problems of a more complex nature, as well as problems that require the use of newly acquired mathematical content.

The program should teach for transfer. Perkins and Salomon also support this objective. They point out that transfer often fails for one of two reasons. The skill may not be learned well enough in the first place. Or perhaps the skill is well learned, but when called for in a new context, it is not treated in the instruction (1991).

The workshop teaches a sequence of lessons designed to avoid both of these pitfalls. Lessons that introduce a skill, guide practice in its use and provide exercises in its application ensure that the skill is well learned. A similar sequence of lessons teach for transfer, focusing first on the skill, then gradually shifting emphasis to the subject matter.

For example, an important transfer application of mathematical problem solving is to the solution of the parts of science problems that are mathematical in nature. In order to facilitate this transfer, I begin with a simple problem involving the conversion of a temperature reading from Celsius to Fahrenheit. By using the *Problem Solving Worksheet* to solve the problem, students begin to recognize the mathematical nature of portions of science problems. Students are encouraged to bring to class problems from their science course. These are analyzed in classroom discussions to determine what part of the problem, if any, is mathematical. The mathematical portion of any problem is solved using the *Problem Solving Worksheet*. With repeated guided practice, the students internalize the procedure as it applies in this context and subsequently apply it independently to increasingly difficult science problems.

The program should teach metacognition. Metacognition is the knowledge we have concerning our own cognitive processes and products (Presseisen 1991). It is our thinking about our thinking. Metacognition involves us in assembling, coordinating, integrating, monitoring and evaluating knowledge as we learn it. It exercises awareness and control over

our thinking processes, thereby enabling us to refine and extend these (Fountain and Fusco 1991). Therefore explicit discussion of the cognitive and metacognitive processes involved in learning is a fundamental element of teaching thinking (Martin 1991; Costa 1991b; Costa and Lowery 1989; Fogarty 1991; Quellmalz 1991; Worsham 1991).

The workshop participants are probably not used to practicing metacognitive skills. In order to teach this important process to their students, they are going to have to learn it and model it. Metacognition is described in the first session of the workshop. In that same session, the participants practice metacognitive skills as they think about their own thinking and describe what went on in their minds as they worked through a series of thinking tasks. In the second session the participants generate their thinking skill descriptions. This is a more difficult application of the skill.

The workshop serves only to introduce the participants to the skill of metacognition. It will be clearly indicated that further instruction is necessary.

A comprehensive program should involve many different thinking skills. Although a comprehensive program of teaching thinking should be in place in the school system, no classroom teacher is expected to carry this out single-handedly. The workshop prepares each participant to teach one thinking skill that is frequently in use in his classroom. It provides instruction in how to integrate one or two other thinking skills in that same course. However, due to the time needed for skill learning, the participants

are not advised to teach several skills in any one course. They are clearly discouraged from teaching any skill that is not a very integral part of their subject matter.

Efforts to develop thinking should either teach the skills directly or do something beyond enrichment in general and modeling in particular to provoke students to invent their own thinking strategies. This is the focal point of the workshop: the method of direct instruction in teaching thinking skills. Barry Beyer is the foremost authority on the method of direct instruction in thinking skills. Many experts in the field of teaching thinking either explicitly recommend Beyer's program of direct instruction or propose similar instruction (Costa and Lowery 1989; Martin 1991; Perkins 1991; Presseisen 1991; Quellmalz 1991; Swartz 1987; Swartz 1991; Worsham 1991).

Some critics claim these procedures might be too facile. They claim that thinking is too complex a process to yield to any step-by-step procedural description. They imply that the direct method for teaching thinking is simplistic (Glatthorn and Baron 1991).

One of the first steps in Beyer's method is to write a description of the thinking skill that is to be taught. In order to do this, Beyer recommends a process called *3-D Reflective Analysis.* The process sounds simple: define the skill, do it, then describe what was done.

Using Beyer's method as one tries to describe how one performs even a very simple cognitive operation, all of the complexities and subtleties of the skill come crowding forth. Consider some of the difficulties I encountered as

I developed a description of mathematical problem solving. (See Appendix A, 101.) When I tried to define the skill I was at a loss for words. Even in the literature of experts such as Polya, Schoenfeld, Lochhead and Whimbey, there was no definition stated. I was struck by the gap between knowing what something is and being able to articulate its nature.

In doing the skill, I worked on a variety of problems from arithmetic, algebra and geometry. I described the steps I worked through after solving each problem. Then came the difficulty of generalizing. I had to examine each procedure and determine the elements common to all. Again I was impressed by the gap between knowing how to do something and being able to communicate the process. By the time my thinking skill description was written, I had practiced a broad range of thinking skills myself.

Contrary to the claim that focusing on specific thinking skills reduces thinking to something absurdly rote, I believe this descriptive process makes the complexities of thinking explicitly manifest. After practicing *3-D Reflective Analysis* one is more likely to appreciate the many ways a thinking process can be carried out, the enormity of the quantities of knowledge that can be brought to bear and the difficulties of recognizing all the circumstances where the skill might be used. I do not think one comes away from this process with an all-too-neatly packaged little formula for a thinking skill; rather one gains a new awareness and respect for the skill, a sense of one's own incomplete mastery of it and a desire to compare notes with experts in a field whose very existence was unperceived before this experience.

Other critics warn that teaching thinking skills can be a reductionist trap. They refer to workbooks that feature dozens of micro-thinking skills to be drilled in rote fashion in artificial contexts devoid of meaningful content (McTighe and Clemson 1991). Beyer is well aware of this danger. He stresses the importance of teaching a thinking skill when the need for it arises in a learning situation (1991, 46). In the generation of thinking skill descriptions, he counsels that there is never "one right way" to perform a skill. If two teachers who are trying to describe the same skill generate very diverse procedures for performing the skill, Beyer does not advocate consensus. He advises listing both procedures for the skill. He also issues reminders that any thinking skill description is based on limited experience, and thus is very tentative (1991, 26).

Although there are other programs that reflect David Perkins' recommendations, Beyer's method has qualities that make it superior. For example, Perkins promotes his own concept "knowledge as design". He proposes that any knowledge can be approached using the following four questions (1987a): What is its purpose? What is its structure? What are model cases? What arguments serve to explain and evaluate the object? By taking on the structure of any knowledge, Perkins' method is far more general than Beyer's. It is also more vague and therefore less readily applicable. One of the strengths of Beyer's approach is its reliance on clear step-by-step procedures for generating thinking skill descriptions, lesson plans and unit plans. These procedures are very helpful for beginners getting

started in a complex task. The participants should find this practical approach easy to remember and use.

Barry Beyer's Teaching Thinking Skills: A Handbook for Secondary School Teachers is the textbook for the workshop. It is an excellent resource for the direct teaching of thinking skills. This textbook features an active approach to teaching the direct method and also advocates for the use of active learning in the classroom. Therefore, both indirectly and directly, this textbook supports the workshop's emphasis on the importance of active learning in a classroom structured for thinking.

Beyer's textbook also presents several examples of skill descriptions, lesson plans and lesson sequences including many excellent graphic organizers.

Graphic organizers are defined by John H. Clarke as "an organizing pattern a student can use to represent relationships in the information they encounter in school" (1991, 224). A graphic organizer gives teachers and students a way to visually display simple relationships among basic facts and ideas. These facts and ideas can then be manipulated to better understand their inter-relationships. Graphic organizers can be used to help students in the following ways (Clarke 1991):

- To develop a clear purpose for studying content.
- To represent what they know as a basis for additional learning.
- To become actively involved in proposing and testing possible relationships in the subject matter.

- To control the process of their thinking as they apply different organizational patterns.

- To develop a medium of communication and deliberation.

Jay McTighe and Frank Lyman suggest these additional uses for graphic organizers (1991):

- To serve as an aid to memory.

- To provide a common frame of reference.

- To provide an incentive to act.

Beyer's graphic organizers are, therefore, useful in the workshop not only as instructional aids for teaching the workshop content but also as models for the development of instructional aids for any course.

The only weakness I perceive in Beyer's textbook is in the area of evaluation of thinking skills. Beyer provides sound instructions for designing thinking skill tests based on matching the teacher's instructional goals to the test items. However, the examples of tests in the textbook fail to exercise the students' abilities to think. The multiple choice items are very easy. Because of this I have supplemented Beyer's examples with examples and suggestions from other sources (Charles et. al. 1987; Norris 1989; Wiggins 1991).

Although Beyer's examples of thinking skill tests are lacking, he provides other evaluation instruments that are very good. Two are easy-to-use forms for observing students' behaviors as they exercise thinking skills.

thinking skill lesson plans. These four add to the large collection of useful course materials that Beyer's textbook contributes to the workshop.

Teachers Need to Experience the Instructional Innovations that Support Skillful Thinking in the Classroom

Joseph Onosko and Robert Stevenson identify five effective strategies for staff development in teaching thinking:

- Help teachers analyze and develop a conceptualization of thinking.
- Provide opportunities for teachers to practice and discuss instructional strategies.
- Provide time for teachers to discuss workshop ideas and techniques and to formulate classroom applications.
- Engage teachers in higher order thinking, such as authentic problem solving, in their subject areas.
- Model specific instructional strategies for promoting student thinking.

The workshop curriculum reflects all five of these strategies, with special attention to the fifth, in ways that are listed below.

Help teachers analyze and develop a conceptualization of thinking. Beyer's conceptualization of thinking is developed and discussed in the workshop as part of the background for teaching thinking. This concept is presented in terms of a definition and a model that supports direct instruction in thinking skills.

Provide opportunities for teachers to practice and discuss instructional strategies. Opportunities for teachers to practice and discuss instructional

strategies and workshop ideas are provided as the participants write their thinking skill lessons and discuss their plans of action.

Provide time for teachers to discuss workshop ideas and techniques and to formulate classroom applications. Every session after the first opens with a discussion of the participants' work and an extension of the workshop ideas previously presented. The unit plan required of every participant is a significant classroom application.

Engage teachers in higher order thinking, such as authentic problem solving, in their subject areas. The participants engage in many opportunities for higher order thinking. The process of *3-D Reflective Analysis* requires that they not only solve problems in their academic discipline, but that they afterwards engage in a metacognitive reflection on what they did as they solved the problems.

Model specific instructional strategies for promoting student thinking. Instructional strategies for promoting student thinking are the most important element in the design of the workshop. Careful attention is given to the creation of an atmosphere supportive of thinking, discussion techniques that facilitate higher order thinking and the use of structured cooperative learning strategies. Each of these instructional design elements is detailed below, with attention to how it is integrated in the workshop.

An atmosphere supportive of thinking. It is important for a teacher to let his students know he values thinking, especially their thinking (Berman 1991). Everything possible should be done in a classroom to accomplish this,

and the students should be aware of this from the moment they enter the classroom. The physical setting of the room, the way large group instruction is carried out and the way small group instruction is conducted are all matters of concern for the classroom teacher to address.

Cognitive education should include the development of sensory acumen. A teacher should, therefore, be sensitive to the artistic features of the environment around him and to the qualities of experience that evoke joy, exhilaration and awe. Such attention to aesthetics helps sustain his students' motivation and interest (Costa 1991a).

The opening of the workshop is carefully planned to invite the participants to think and express their thoughts, and to enjoy this process. The maxim on the door reflects the value the teacher places on thinking. The unfinished bulletin boards cue the participants to the active nature of the learning that will occur. The instructions for completing one bulletin board require the participants to bring in pictures from magazines that somehow catch people in the act of thinking. This activity fosters transfer as the participants look for examples of their learning outside of class, in the context of their day-to-day lives. The circular seating arrangement alerts the participants that this is not just another lecture. Their contributions to the workshop are essential to its success. The welcoming activity serves to facilitate interaction among strangers, to break down the barriers of unfamiliarity among them and to pique their interest in one another.

Discussion techniques that facilitate higher order thinking. Many experts in the field of thinking identify discussion as one of the most important vehicles there is for teaching thinking (Beyer 1991; Paul 1987; Ennis 1987; Berman 1991; Barell 1991). Costa and Lowery state that greater gains are made when teachers spend time discussing, explaining, asking higher level questions and stimulating cognitive processes than when students work quietly. To learn to think students must engage in discussion and come to value thinking (1989).

Costa and Lowery present some surprising findings concerning discussion. During discussion, a teacher's responses have a great influence on the development of the student's self-concept, attitudes toward learning, achievement and classroom rapport. The teacher's response behaviors effect students' thinking in either a terminal or an extending manner. Termination tends to close thinking down while extension opens thinking up. Terminal behaviors include criticizing or praising students. Extending behaviors include the use of silence, acceptance, clarification, and the provision of information (Costa and Lowery 1989).

Criticism lowers the students' self-esteem. Praise makes students dependent on others, building conformity. Costa and Lowery suggest the following guidelines for the use of praise:

- State your criteria along with the praise.

Praise should not be used as a motivator. A teacher should praise, not the student, but the learning product or routine procedures. Rewards have a detrimental effect on higher level problem solving. The performance of learning new tasks, skills and processes requires cognitive risks and exploration which are inhibited by praise and promised rewards (Costa and Lowery 1989).

The following behaviors are suggested to invite student thinking during discussion (1989):

- Use silence (wait time): If students are to do their own thinking, reflecting and problem solving, the teacher needs to be comfortable waiting for a response. Answers will be more complete, student to student interaction will happen and the traits of the good thinker--thoughtfulness, reflectiveness, restraint of impulsivity--will be fostered.

- Use accepting responses: Non-evaluative responses allow students to take risks and interact with other students. Teachers should practice whichever of the following responses is appropriate to the situation:

    - Passive acceptance: Indicate that the ideas have been heard;

    - Active acceptance: Paraphrases; this indicates the message has been heard and understood;

    - Empathic acceptance: Indicate that both feelings and content are accepted;

    - Clarifying: The intent here is to better understand the student's ideas. Communicate that the idea is worth hearing. Students become more purposeful.

    - Providing information: The teacher provides facts or the means to find facts.

The teacher can create an environment responsive to students quests for information (1989):

- by providing feedback;
- by providing information, equipment and resources;
- by surveying the group for their feelings or input;
- by labeling thinking processes or behavior.

These behaviors show that the teacher cares and is listening. They provide a warm climate and a model for rational behaviors (1989).

Teachers must learn how to embed, in their everyday classroom language, opportunities for students to hear cognitive terminology and be presented with day-to-day challenges to think. The use of a specific vocabulary for thinking helps make reflective thinking part of the students' everyday lives. The creation of labels is a tool we use to structure our perceptions. "Think" is too general a term. A teacher should try to refer to a specific skill: "compare", "predict", "classify"," analyze", "speculate". Teaching students to be alert to thinking processes expressed in written and spoken language can help them become aware of their own language and thought (1989).

Discussions are an important part of every session in the workshop. By practicing the behaviors Costa and Lowery recommend for promoting thinking during a discussion, the workshop teacher models for the participants an effective way to lead discussion in their classrooms.

The use of structured cooperative learning. The most highly recommended of all active learning strategies is cooperative learning (Beyer 1991; Kagan 1992; Johnson and Johnson 1991; Berman 1991; Swartz 1991; Costa 1991a; Pressesein 1991; Paul 1987; Worsham 1991; McTighe and Lyman 1991; Sternberg 1987a). Cooperative learning is the instructional use of small groups so that students work together to maximize their own and each others' learning. The opportunity for interpersonal exchange and the intellectual challenge of conflicting ideas promote critical thinking, higher levels of reasoning and metacognition. Cooperative learning promotes higher achievement than either competitive or individual learning strategies. Mastery, retention, the quality of reasoning, the generation of new ideas, the production of solutions and transfer are all observed to increase through the use of cooperative learning (Johnson and Johnson 1991).

McTighe and Lyman report the following benefits of cooperative learning (1991):

- Students produce longer and more elaborate answers.
- Students support their inferences with evidence and logical argument.
- Students produce a higher quantity of speculative responses.
- Students participate more in discussion.
- Students' achievement improves.
- Students become involved and interact, resulting in positive effects on their attitudes and achievement.

The greatest challenge to a teacher who wishes to experience these benefits of cooperative learning is the issue of control. How does a teacher keep the students from giving in to a natural desire to socialize rather than work? How does he keep the individual members of several different groups on task?

To handle this challenge, Spencer Kagan suggests the use of structured cooperative learning activities. In structured cooperative learning activities, students are not simply given a task and put together in groups to work through it. Productivity is ensured by applying the following three principles to every cooperative learning activity: simultaneous interaction, positive interdependence and individual accountability (1992). Each of these is discussed briefly below.

Simultaneous interaction refers to the increase in active learning made possible by the use of small groups. For example, consider a class of twenty-four students. In the traditional classroom, one person talks and twenty-four listen. In groups of four, six can be talking while eighteen listen. In pairs, twelve talk while twelve listen.

How does all this talking increase learning? It is important to keep in mind that discussion is not only a means to an end but also an essential ingredient of thought formation (Sternberg 1987a). Social interaction focused on a learning task is the wellspring of higher order thinking (Pressesein 1991). Therefore the use of small groups increases active learning in the classroom.

Positive interdependence means that the success of every team member depends on the contribution of each one. When students take responsibility for the learning of others, their own understanding increases.

Individual accountability means that each team member's responsibility can be assessed.

Building each of these three principles into cooperative learning activities keeps the students on task for several reasons (Johnson and Johnson 1991):

- The expectation on the part of the student that he will have to summarize, explain and teach impacts on the strategies he calls into play to process information.

- Discussion promotes more frequent summarizing, explanation and elaboration. Meaning is formulated through the process of conveying it.

- The interaction of students with incomplete information, different perspectives and facts facilitates synergy, a synthesis where the sum of the information is greater than the parts.

- Ideas are externalized and peers monitor the process of their production. Peer monitoring is an important step toward self-monitoring.

- Feedback on the quality of ideas is immediate.

- Conflicts will arise. When these are handled well, they foster a very high level of thinking.

Several structured cooperative learning activities serve as vehicles for learning in the workshop. This introduction to structured cooperative learning gives the participants the chance to experience how effective and enjoyable these strategies are. It also provides the participants with

cooperative learning activities that they can adapt for use with their own classroom learning.

I have defended the four principles of the instructional design of the workshop curriculum with evidence gathered from experts in the field of thinking. I would like to conclude this rationale with a defense of these principles based on personal experience.

My belief that skillful thinking should be a major goal of education is based on the positive effects that such teaching has had on my students. Focusing on the thinking skills involved in learning mathematics has improved my students' understanding and competence in mathematics. Moreover, my students truly enjoy exploring and extending their thought processes. Since I have begun using the method of direct instruction, my students are fountains of information when it comes to devising and describing the strategies they use to solve problems. It makes me wish that these fountains were bubbling forth in areas other than mathematical problem solving, in every classroom, at every grade level.

My belief that thinking should be taught in the content area comes from my own frustration early in my teaching career. I hated it when my students left word problems blank! And I deeply desired to know what to do about it.

Since I have understood how to approach the situation from a thinking skills perspective, it has only been a matter of waiting for the teachable moment. I know that moment will arrive, and at that moment the

skill teaching begins. When my students reach another roadblock, the skill teaching is extended. And at last, at some point, they are jumping ahead of me to remove the obstacles in our path.

If I had to teach a broad range of skills in a stand-alone course, would I be able to do it with this degree of intensity? Is anyone better prepared than the classroom teacher to deal with the nuances of the skills particular to his field?

My belief that the direct method of teaching thinking is a good place to start the complex task of teaching skillful thinking reflects my own positive experiences of this beginning. This method is easy to learn, easy to remember and easy to use. It gave me a deeper appreciation of problem solving and stimulated my curiosity about the skill. It caused me to initiate research that I am carrying out still. My own practice of problem solving has become more extensive, more interesting and more creative.

Best of all, through this accessible method has come an interest in other thinking skills, and in thinking in general. It is an interest easy to share with my students. Teenagers are very curious about every aspect of themselves--including the workings of their minds. They enjoy discovering who they are as "thinkers".

Finally my belief that teachers need to experience the instructional innovations that support skillful thinking reflects my understanding of how I learned to teach. My teaching methods imitate the methods of my favorite teachers. My best educational experiences came when I worked with other

students in pairs, or on teams, or when I had to make a presentation or do a project. Unfortunately these experiences were rare. For many teachers, I suspect they were non-existent. That is why it is important that, when teachers become students, as they do in a workshop, the instructional strategies should feature active learning. If the teachers find that they learn a lot and that they enjoy the process, they will be encouraged to make these strategies their own.

CHAPTER III

THE WORKSHOP CURRICULUM

The summer workshop curriculum is designed to teach the method of direct instruction in thinking skills to secondary school teachers. This is accomplished by guiding each of the workshop participants through his development of a unit plan for teaching a single thinking skill relevant to a particular subject matter course that he teaches. This unit plan is completed in the week following the workshop and submitted for evaluation.

On the next pages is a presentation of the curriculum for the summer workshop. Each of the five three-hour sessions is described in terms of the following components:

- Goals.
- Objectives.
- Outline.
- Content.
- Instructional Strategies.
- Evaluation.

All of the course content for the first three sessions is adapted from Barry Beyer's Practical Strategies for the Teaching of Thinking and Teaching Thinking Skills: A Handbook for Secondary School Teachers. The latter serves as the textbook for the workshop. The content in the fourth session is also adapted from Barry Beyer, except for that concerning the evaluation of

thinking skills. This content is generalized from How to Evaluate Progress in Problem Solving by Randall Charles, Frank Lester and Phares O'Daffer.

It is a very difficult task for a reader to bring someone else's written curriculum to life. During instruction, all of the elements of a lesson design are in play together. The goals and objectives, the content, the instructional strategies and materials and the evaluation interact within the framework of the lesson's plan to bring about learning in the classroom. When a curriculum is subjected to writing, however, these elements are laid out separately. In order to imagine the interplay among the elements, the reader may find himself flipping back and forth among text and appendices. This task is cumbersome and I apologize to the reader for the patience here required.

Session One: Introduction to the Workshop

Goals.

The first session has four goals:

- To motivate the teaching of thinking skills in the academic classroom.
- To preview the method of direct instruction for teaching thinking skills.
- To provide a conceptualization of thinking supportive to this method of instruction.
- To prepare each participant to select a thinking skill to teach.

Objectives.

The objectives for the first session are as follows:

- The participants will engage in a three-part welcoming activity in which they interact to solve a problem, interview one another and introduce one another to the class.
- The participants will receive and preview a workshop syllabus with descriptions of the daily assignments and the final project.
- The participants will engage in a variety of experiences that lay the foundation for teaching thinking skills: why we should teach them, how we can teach them, what thinking is and how the skills relate to thinking.
- The participants will take part in activities that feature four cooperative learning structures: *Match Mine, Three Step Interview, Think-Pair-Share* and *Numbered Heads Together.*
- Each participant will select a thinking skill to teach.

Outline.

The first session's activities are structured according to the following outline:

I. Welcome

II. Workshop Overview with Expectations

III. The Basics

A. Why Should We Teach Thinking Skills?

B. How Can We Teach Thinking Skills Effectively?

C. Just What Is Thinking Anyway?

1. A definition of thinking

2. A model of thinking

3. A close-up on the thinking skills

D. Summary of the Basics

IV. Selecting the Thinking Skill You Will Teach

Content.

The content for the first session is presented below in the order in which it appears in the outline.

Why should we teach thinking skills? Integrating the teaching of thinking skills with subject matter results in improved student thinking and more meaningful content learning.

How can we teach thinking effectively? In order to improve our students' thinking, we usually provide opportunities to think: we design and pose challenges that require the higher levels of thought (comprehension, analysis, synthesis and evaluation). This is necessary but, for most students, it is not sufficient. We need to supplement these challenges with instruction in how to meet them. This means we need to teach the required thinking skills directly. When, in the process of classroom instruction, the need for a particular thinking strategy arises, we should:

- Focus on the key thinking skill involved in the learning.
- Describe this skill in terms of the procedures, rules and knowledge required for the performance of the skill.
- Provide explicit instruction and guided practice in the use of the skill in a variety of contexts and for a variety of purposes.

Therefore in order to teach thinking skills we must be able to:

- Identify and define the key requisite skill involved in the learning.
- Plan and conduct lessons on the learning.
- Assess our students' proficiency in the use of the skill.
- Integrate the skill with our students' subject matter learning.

Just what is thinking anyway? Thinking is a complex process that is only partially understood. Forming a concept of the nature of thinking can be facilitated by a definition and a model.

A definition of thinking. Thinking, in its broadest sense, is the search for meaning.

A model of thinking. For our purposes, thinking can be conceived as an activity with three key components: mental operations, knowledge and dispositions. (See Appendix A, 102.)

The *mental operations* are the processes we bring to bear on information as we try to make sense of it. These mental operations fall into two categories of activity: cognitive and metacognitive. The cognitive operations are those we use to find or generate meaning from the information gathered by our senses and/or stored in our memory. The metacognitive operations are those we use for thinking about our thinking. These operations direct our efforts to find or generate meaning. Planning a thinking strategy, monitoring our progress as we work through a problem and assessing the use of a particular thinking strategy are all examples of metacognitive operations.

The *knowledge* component of thinking is the main focus of most classroom instruction. By *knowledge* I mean the result or product of knowing, the information or understanding acquired through experience, and practical ability or skill. Knowledge in the subject about which we are thinking is, of course, indispensable. This is what we hope our students will acquire.

There are other aspects of this knowledge component as well. Our knowledge about thinking itself affects the nature of our thought. This knowledge is comprised of heuristics and concepts.

Experience teaches us heuristics, or rules of thumb, concerning how to execute various thinking processes. "If you don't do your own thinking, someone else will be happy to do it for you" is one instance of these common principles.

Our concept of the nature of knowledge itself is also important. One widely held conception of knowledge is that it consists of a set of absolute truths. A more enlightened view holds that knowledge is "fragmentary, selective, subjective and changeable, and thus most tentative" (Beyer 1987, 19). Teachers who hold to this second view acknowledge the importance of teaching critical thinking. Such conceptions, like the heuristics, work to shape our thinking in conjunction with the subject of our thought.

Our attitudes toward thinking, or our *dispositions*, comprise the third component of thinking. How we feel about a particular thinking task affects how well we perform it. For example, effective thinking requires, among other things, a tolerance for ambiguity, a willingness to suspend judgment, and a respect for evidence and the use of reasoning.

In any act of thinking these three key components--mental operations, knowledge and dispositions--work closely together, building on one another and often becoming indistinguishable from one another. The intention of this workshop is to address the mental operations--the skills we apply when we are thinking. By focusing on this component of thinking we hope to be able to improve our students' learning.

A close-up on the thinking skills. Lists of thinking skills are almost as numerous as experts in the field of thinking. There is no agreement on a definitive list. We will rely on Beyer's list as a springboard. (See Appendix A, 103-105.)

Beyer's list is arranged hierarchically on three levels: thinking strategies, critical thinking skills and micro-thinking skills.

Thinking strategies. The most complex cognitive operations are the thinking strategies such as problem-solving, decision-making and conceptualizing. These operations are sequential: they can be carried out by following a set of steps.

Critical thinking skills. Somewhat less complex than thinking strategies are the critical thinking skills, the skills we employ to judge the value and truth of knowledge. The list of these skills does not represent a sequence of steps to be carried out. Critical thinking does not consist of a sequence of operations performed in a set order. The critical thinking skills can be used in any order and in any combination. They are applied both directly to knowledge and as needed in every step of the thinking strategies.

Micro-thinking skills. Least complex are the micro-thinking skills for information processing and reasoning. The micro-thinking skills are the building blocks for both critical thinking and the thinking strategies. Each micro-thinking operation involves a limited number of steps, procedures and rules. The skills for information processing are derived from Bloom's

taxonomy. They are arranged in increasing order of difficulty. The micro-thinking skills are used three ways:

- They serve to make information meaningful.
- They are called into play in the application of each critical thinking skill.
- They are active in each step of the thinking strategies.

Summary of the basics. To recapitulate, thinking can be considered to have three components: mental operations, knowledge and dispositions. An important aspect of the mental operations are the cognitive operations. The cognitive operations, or thinking skills, may be arranged hierarchically. At the highest level are the complex thinking strategies. On the next level are the critical thinking skills, which contribute to the complex strategies as well as work alone. On the third level are the fairly straightforward micro-thinking skills. These are called into play in diverse combinations in all thinking.

In our classrooms, we are concerned with our students' acquisition of subject matter knowledge. We want our students to learn the subject we are teaching. Because of that we focus on the knowledge component of thinking, we present our students with knowledge and exercises designed to help them process that knowledge. Because these exercises require thinking, they engage all three components of thinking: knowledge, skills and dispositions. In order to maximize our students' learning, we must teach, not only knowledge, but the skills and dispositions necessary to the acquisition of that

knowledge. In this introductory workshop we are concentrating on the thinking skills and how to teach them. This requires a temporary shift in focus from knowledge to skills. However, that shift can make a great difference in the learning in our classrooms. The thinking skills our students use on their own may be inefficient or dysfunctional. For some learning, our students may not have developed the requisite skills at all. However, effective ways to acquire any thinking skill or strategy can be identified and taught. Therefore by focusing on teaching the specific thinking skills appropriate to the subject matter knowledge, teachers can improve their students' learning of that subject matter.

Teaching thinking skills is a worthwhile endeavor. As psychologist Robert Sternberg points out, bodies of knowledge change and grow, but the thinking skills will serve us all our lives. They never go out of date. They enable us to acquire knowledge and to reason with it (Beyer 1987, 4).

Selecting the thinking skill you will teach. Difficulties in selecting a thinking skill can be addressed using the following considerations:

- Does a state curriculum, district program of studies, school policy or department head require you to teach certain skills? If so, select one of these. If not you need to make a decision.

- Clarify your goal. Why are you teaching thinking? Consider what you want your students to be able to do better. What thinking skills do your students need for this?

- Consider the following options:

    ° Examine books on teaching thinking skills.

    ° Examine student textbooks, or the results of diagnostic assessments and/or standardized examinations students have taken.

    ° Consult the students.

    ° Use *Beyer's List of Thinking Skills.*

- Consider the following criteria:

    ° The thinking skill should be used by students outside of school as well as in learning subject matter.

    ° It should be used by students in more than one academic subject at the current grade level.

    ° It should be recommended for instruction by several recognized experts.

    ° Your subject matter should contain many opportunities for the practice of this skill.

    ° Your students should have demonstrated a need to learn this skill.

Instructional Strategies.

Pre-workshop preparation of the classroom. The classroom in which the workshop is taught should be inviting and interesting. It should model the teacher's value of thinking, stimulate reflection on thinking and accommodate active learning. The following is a checklist of specific recommendations for creating the desired atmosphere in the workshop classroom.

• Make a sign for the door with the following quotation from Luis Alberto Machado, former Minister of Intellectual Development in Venezuela:

> All human beings have a basic right to the full development of their intellects.

• Prepare two bulletin boards for class use. Cover each in a different colored background paper. Entitle one *The Thinker's Cartoon Collection*; the other *Thought-Full Words and Deeds.*

The Thinker's Cartoon Collection will eventually be covered with a patchwork quilt of cartoons labeled with matching thinking skills principles. Workshop participants will assemble these during the first of the workshop activities in the first session. Before the workshop, however, it is blank except for its title, inviting curiosity.

Thought-Full Words and Deeds contains oversized versions of the following lists of words collected by Arthur Costa and Lawrence Lowery (1989, 25-29):

° *Gather information*

see	view	hear
listen	taste	feel
touch	smell	sniff

° *Recall information*

describe	list	identify
recall	define	recite
complete	count	name

° *Make sense out of information*

synthesize	analyze	categorize
explain	classify	compare
contrast	group	relate
experiment	organize	distinguish
sequence	summarize	state causality
make analogies		

° *Apply and evaluate actions in novel settings*

apply a principle	imagine	plan
evaluate	judge	predict
extrapolate	create	forecast
infer	hypothesize	speculate
generalize	build a model	design

A few magazine cut-outs of these words in action form an incomplete border for the lists. (The cut-outs are pictures of a person sniffing flowers, a person looking through a telescope, a person reading a computer screen, etc.) In the first session of the workshop, the participants will be encouraged to complete the border with their own cut-outs from home.

Reference to these lists of words during the workshop can help both the teacher and the participants to focus on specific thinking skills and use language about thinking precisely.

• Make sure the classroom furniture accommodates three configurations:

° a wide circle of seating for discussion;

° cluster seating of three to five for cooperative learning activities;

° rows of seating for teacher and/or participant presentations.

Arrange the seating in a circle for the opening of the first session.

The welcome activities. As participants arrive, they are asked to complete a *Participant Information* form. (See Appendix A, 106.) Then, in order to help the participants get to know each other and to open productive lines of communication among them, there are two activities: *Finish the Bulletin Board* and *Introductions.*

Finish the Bulletin Board uses the structure *Find Your Match.* (See Appendix B, 137.) Begin by calling the participants' attention to *The Thinker's Cartoon Collection* bulletin board. Use the *Find Your Match Activity Packet.* This packet contains:

- twenty single frame cartoons, each six inches square;
- twenty thinking principles printed across the bottom of different colored 8.5" by 11" sheets of paper (frames).

Distribute one cartoon each to half the class; the corresponding thinking principle for each cartoon to the other half of the class. Instruct the participants to walk around and find the person who has the information that matches his own. When these pairs have found one another, they should mount the cartoon above the thinking principle on its frame, staple their product to the bulletin board, then sit down next to one another.

The twenty cartoons in the *Thinker's Cartoon Collection* are by Gary Larson. Each one derives its humor from the illustration of some pretty poor, but all too familiar, thinking. Each one belongs in a particular frame that bears a label for the thinking principle illustrated. For example one cartoon captioned, "Confession time, Mona: I've lead you astray," depicts a barroom

where a male wolf is having a drink with a female sheep. Her eyes are taking in the fact that, besides herself, there are only wolves in the establishment--and she is quite alarmed (Larson 1993, 5). The frame that matches this cartoon is labeled, "If you don't think for yourself, someone else will be happy to do the thinking for you."

What can we say about *The Thinker's Cartoon Collection* bulletin board when it is all assembled? Look at all these perils of poor thinking! Haven't we all found ourselves in some of these situations? By illustrating the dangers of thinking badly, these images encourage us to value thinking well.

This is a good time to focus on the other bulletin board *Thought-Full Words and Deeds.* These are sorted lists of verbs that express thinking skills. Indicate that some of them have been illustrated by the magazine cut-outs on the border. Ask the participants to keep these words in mind as they read magazines at home over the next few days, and to bring in pictures that show the actions expressed by the words in order to complete the border.

This assignment facilitates the transfer of this vocabulary to the daily lives of the participants. Regarding magazine images with a purpose, they will see these common images in terms of the active thinking illustrated therein.

Introductions uses the structure *Three Step Interview.* (See Appendix B, 138.) It provides the participants with a non-threatening way to share with the class some basic information about themselves. The participants

exchange *Participant Information* forms with their partners from *Find Your Match* as the basis of their interviews. When the interviews are completed, each participant introduces his partner to the class.

Course overview with expectations. In order that the course content and expectations are clear, the teacher distributes a written syllabus with descriptions of the daily assignments and the final project. (See Appendix A, 107-111.) A brief discussion clarifies this information.

Why should we teach thinking skills? This question is addressed with two activities. In the first, the teacher shares anecdotal evidence from her own classroom that teaching the skill of problem solving contributed to the learning of mathematics. The second activity calls for the structure *Think-Pair-Share.* (See Appendix B, 139.) Participants work in teams formed according to academic discipline. The topic of the activity is: "What do you wish that your students could do better?" Instruct the participants to be as specific as possible; to focus on a particular objective of a single course they teach. They may want to use the *Thought-Full Words and Deeds* bulletin board to generate ideas of thinking skills their students do not perform well.

How can we teach thinking skills effectively? Participants are prepared for the content with an activity that uses the structure *Think-Pair-Share* centered on the question: "What do you do in your classroom now to make your students think?" The participants are urged to be specific: to limit their attention to one course and one objective of that course. It is anticipated that the participants are going to recall exercises they assign that challenge the

higher levels of thinking. The limitation of this approach can be pointed out with another question the participants answer only in their minds: What do you do when your students cannot do these exercises? The content is presented in a lecture format and summarized with the overhead *How Can We Teach Thinking Skills Effectively?* (See Appendix A, 112.)

Just what is thinking anyway? Participants are prepared for this content by the posing of three questions: How can we define thinking? What model of thinking would be useful for us? What is thinking, and how do the thinking skills relate to it?

A definition of thinking. Beyer's definition is presented. Note that a definition is informative but not helpful when it comes to the question of how to teach thinking skills.

A model of thinking and a close-up on the thinking skills. Since thinking is an active process, the participants are prepared for this content by doing some thinking. Teams are disbanded; desks are arranged in rows. Individually the participants complete the *Think!* worksheet. (See Appendix A, 113.) This worksheet features six thinking tasks from various academic disciplines. Each one engages specific, identifiable thinking skills, bodies of knowledge and dispositions which the participants may or may not possess. This activity is followed by completion of a second worksheet *Think! Again.* (See Appendix A, 114.) This worksheet elicits the participants' reflections

upon their own mental processes and feelings as they worked through each thinking task.

When these two activities are completed, the participants have performed some thinking tasks and engaged in some metacognitive activities. Using the overhead *Components of Thinking at Work When We Think* (see Appendix A, 115), the participants work together in a large group discussion to identify the knowledge, skills and dispositions that were needed for each thinking task. A lecture generalizes the content with the aid of the two overheads *Key Components of Thinking* and *Beyer's List of Thinking Skills.*

Summary of the basics. The participants return to their teams for this closing activity which uses the structure *Numbered Heads Together.* (See Appendix B, 140.) Each team is assigned to summarize one of the following objectives.

- Why should we teach thinking?
- How can we teach thinking effectively?
- What are the key components of thinking?
- How do thinking skills relate to thinking in general?

Each team must make sure that every team member can summarize their designated objective. One person from each team writes the team summary on the chalkboard. The summaries are discussed and amended as necessary.

The session closes with a brief review and preview: Note that today we explored some of the foundational information about thinking. We are ready therefore for the first step in teaching thinking skills. You need to select an appropriate thinking skill to teach. Part of your home assignment requires you to give careful thought to a question we began to consider in class. What do you want your students to be able to do better? After reflecting on this question, you will be concentrating on identifying the key thinking skill necessary to perform this objective. Collecting the materials you use to teach this objective will be helpful in this identification process. Tomorrow you will prepare to teach that thinking skill by writing a description of it.

Evaluation.

To evaluate the success of this first session, reflects on these questions:

- Were the participants comfortable with one another?
- How well did they communicate with one another?
- Did the teams stay on task?
- Did the questions concerning the course syllabus indicate the need for greater clarity in content or instruction?
- Did the team summaries adequately express the content presented in the lectures?

Session Two: Thinking Skill Descriptions

Goal.

The goal of the second session is to prepare each participant to write a description of his selected thinking skill.

Objectives.

The objectives for the second session are as follows:

- In individual conferences with the teacher, the participants will discuss their selected thinking skill, revising and refining as necessary.
- The participants will preview the instructions for writing a thinking skill description.
- The participants will determine the basic characteristics of thinking skills in general.
- The participants will study several examples of thinking skill descriptions and discern the components of the structure of these.
- The participants will use the process of *3-D Reflective Analysis* to generate first drafts of descriptions of their selected thinking skills.
- The participants will practice metacognitive skills as a part of the process of generating their thinking skill description.

Outline.

The second session's activities are structured according to the following outline:

I. Overview

II. Your Selected Thinking Skill

III. General Information about All Thinking Skills

IV. Examples of Thinking Skill Descriptions

V. Generating a First Draft of a Thinking Skill Using *3-D Reflective Analysis*

Content.

The content for the second session is presented below in the order in which it appears in the outline.

Overview. Before we can teach anything, we have to know what we're teaching. This is just as true of thinking skills as it is of our course subject matter. We can learn about any thinking skill using the following set of instructions:

- Select a particular thinking skill.
- Determine what we need to know about thinking skills in general.
- Examine descriptions of the attributes of several thinking skills.
- Use a process of reflective analysis to identify the key attributes of the thinking skill selected.
- Identify the key attributes of this thinking skill as described by specialists.

- Draft a description of the major attributes of the thinking skill.

- Revise the skill description incorporating feedback from others.

- Rewrite the skill description as appropriate for the grade or experience level of your students.

General information about all thinking skills. Every thinking skill involves a procedure, rules and knowledge (or criteria).

- The *procedure* is a series of steps and substeps by which the skill is carried out by those who are proficient in its use. This is what one does mentally when performing the skill.

- The *rules* are principles one follows which inform and guide the execution and application of the procedure.

- The *knowledge* (or *criteria*) are those applied in carrying out the procedure or following the rules. Knowledge is the set of concepts, heuristics, principles, etc. that are prerequisite to the skill. Criteria are standards or conditions that must be met for something to be judged an example of what it says it is.

There are three reasons why this set of knowledge about a thinking skill is important:

- It keeps students focused on the major attributes of the thinking skill rather than on the application of the thinking skill.

- It avoids the danger of irrelevant, dysfunctional and erroneous ideas about the skill.

- It helps teachers to prepare assessment instruments for the skill.

Examples of thinking skill descriptions. We should look at good models of thinking skill descriptions but avoid models of the skills we have selected. Realize that any description is incomplete and tentative. Each varies according to the expert who is describing the skill and his purposes. There is no one right way to exercise any thinking skill. Ask yourself: "Is this

what I'd want to know in order to teach this skill? Does the format--label, definition, steps, rules, knowledge--accommodate teaching and learning the skill, or do I need to make adjustments?"

Generating a first draft of a thinking skill using 3-D Reflective Analysis. Team with others in your first attempt. You want first to use *3-D Reflective Analysis,* then see what experts have to say about how your chosen skill is performed. Combine these to describe the skill.

The process of *3-D Reflective Analysis* has the following steps:

- Define the skill to be studied.
- Do it.
- Describe what you did in detail to perform the skill.

We will examine each step more closely.

Define the skill to be studied. Look up definitions of your skill in the dictionary or in thinking skill sources. Compare them. Consider also what the skill is not. Adopt the best definition or write a combined definition. Defining the skill to be studied prepares you mentally for executing the skill expertly, without unknowingly carrying out some other skill.

Do it. By yourself, practice the skill. You need to select data to work on. Choose exercises that are brief (3-5 minutes) so that you can recall later what you did as you carried out the task. If the skill is complex and you must use a

longer exercise (8-10 minutes), practice the skill with a partner willing to record a protocol of your thinking processes.

Describe it. After carrying out the skill, ask yourself questions such as:

- What did I do first? Why? How did I do that?
- What did I do next? Why? How did I do that?

Examine your answers and record them on a blank *Thinking Skill Description* form under the appropriate headings. This helps to identify the useful aspects of the skill. Your answers to the question, What did I do ...? will help you generate the steps in the *procedure* for your skill. Your answers to the question, Why? will help provide your *rules*. Your answers to the questions, How did I do that? will supply information about the *knowledge* needed to perform this skill.

The following are some guidelines for this process of identifying the aspects of a thinking skill:

- Do not try to reach a consensus if you and a partner disagree on how a skill should be executed. Identify several different procedures instead.

- Be specific as you answer the protocol questions.
Probe deeply. It is not natural to know all you did as you worked. The mind operates rapidly, and a great deal of probing is necessary to determine what is going on when you think.

- Concentrate initially on identifying the major steps of a skill and obvious rules and knowledge. You do not need to find something for each category, nor to include everything you and your partner identify.

- Avoid idiosyncrasies.

- Focus on the thinking skill rather than on the data. Concentrate on what you did and why.

• Be sure your procedure is identifying how to carry out the skill, not just saying, "Do it."

• Rules often take repeated performances to identify. Examine what problems and obstacles arose as you worked and your resolution of these. Consider when you would use the skill and why. Ask yourself what procedure might precede or follow this skill. Is it one step in other major thinking tasks?

• Generalize, if possible, beyond the immediate task. Use your skill on several different types of data to help do this.

• Remain tentative. Your description is based on limited knowledge. Be open to alternatives, refinements and clarifications. Change your description to include these.

• The more times you use the *3-D Reflective Analysis* procedure, the better your skill description will be.

Instructional Strategies.

The session opens with an announcement: "Today we will be writing first drafts of descriptions of our selected thinking skills using a process known as *3-D Reflective Analysis.* Before starting that, however, we need to clear up any questions you might have about the thinking skill you have selected to teach. We also need to see an outline of what we are about to undertake, with a close-up on a useful structure for a thinking skill description."

Overview, selecting a thinking skill and general information about all thinking skills. The first three topics in the session's outline are begun simultaneously in an overlapping strategy. The class is divided into two teams. Each team is assigned to prepare a presentation for the class.

One team is given the overhead *Instructions for Writing a Thinking Skill Description.* (See Appendix A, 116.) Team members are instructed to use this outline and the previously assigned reading from the textbook to present to the class the *Overview* of the workshop activities for the session.

The other team is given the overhead *Common Characteristics of Thinking Skills.* (See Appendix A, 117.) Team members are instructed to use this outline and the previously assigned reading from the textbook to present to the class the *General Information About All Thinking Skills.*

While the teams are working, holds individual conferences with each participant about his selected thinking skill. During these conferences, further assistance and clarification are provided if necessary.

When the individual conferences conclude, each team is called in turn to make its presentation. After each presentation, lead a discussion to make any necessary revisions or additions to cover the content for these two topics.

Examples of thinking skill descriptions. Display and discuss several sample skill descriptions, suppressing any that describe a skill tentatively selected by a participant. (See Appendix A, 101, for a sample.) Afterwards ask the participants to identify the common components of the structure of each thinking skill description they viewed. Follow up by distributing blank *Thinking Skill Description* forms. (See Appendix A, 118.) These forms list the components of a thinking skill description.

Generating a first draft of a thinking skill using 3-D Reflective Analysis. Use the overhead *Guidelines for* 3-D Reflective Analysis (see Appendix A, 119) to guide a discussion of this content. Teams of two are formed by academic discipline. In these teams, the partners will use the process of *3-D Reflective Analysis* to help one another draft their thinking skill descriptions. While the teams work, the overhead *Guidelines for* 3-D Reflective Analysis is displayed for reference purposes. Circulate among the pairs to answer questions.

The session closes with the announcement that the beginning of the third session will be devoted to exchanging skill descriptions in order to receive feedback from peers.

Evaluation.

In the individual conferences, each participant's selected thinking skill is evaluated according to the following criteria:

- Did the participant identify what he wanted his students to be able to do better? Was this a specific objective from a single course?
- Was he able to identify a key thinking skill for the performance of this objective?
- Does the thinking skill selected meet the following criteria?
    - The thinking skill should be used by students outside of school as well as in learning subject matter.
    - It should be used by students in more than one academic subject at the current grade level.

° It should be recommended for instruction by several recognized experts.

° Your subject matter should contain many opportunities for the practice of this skill.

° Your students should have demonstrated a need to learn this skill.

• Do the participant's selected instructional materials exercise this thinking skill?

Did the participant team presentations of the *Overview* and the *General Information About All Thinking Skills* reflect adequate initial understanding?

After discussing several examples of thinking skill descriptions, were the participants able to name the components of the structure of any thinking skill description?

Were the participants able to carry out the process of *3-D Reflective Analysis*? Was each pair of partners assisting one another to define, do and describe their selected skills?

Session Three: Designing and Teaching Thinking Skill Lessons

Goal.

The goal of the third session is to prepare each participant to write an introductory lesson for his selected thinking skill.

Objectives.

The objectives for the third session are as follows:

- The participants will discuss their thinking skill descriptions.
- The participants will prepare to revise their first draft using advice from colleagues and knowledge of their students' ability level.
- The participants will relate the general principles involved in the learning of any skill to the guiding principles for the direct teaching of thinking skills.
- The participants will learn and teach one another selected information about the three lesson strategies for introducing a thinking skill.
- Each participant will write a first draft of an introductory lesson for his selected thinking skill.
- The participants will take part in the cooperative learning activity *Double Expert Jigsaw.*

Outline.

The third session's activities are structured according to the following outline:

I. Your Thinking Skill Descriptions

II. Thinking Skills Unit Planning

III. Thinking Skills Lesson Planning

IV. Introductory Lesson Strategies

A. The inductive strategy

B. The directive strategy

C. The developmental strategy

D. Essential features of all introductory thinking skill lessons

V. Writing Your Introductory Lesson

Content.

A discussion of your thinking skill descriptions. Thinking is a complex process and our knowledge of it is far from complete. It is possible that there are several different valid descriptions of every thinking skill. For these reasons we must be aware that our thinking skill descriptions are tentative at best. They should be subject to continuous revision as we practice, teach and study the thinking required by our academic disciplines.

Rounding out your description with advice from the experts, colleagues and students. Study as many other descriptions of your skill as you

can, keeping in mind that each is tentative. You may also want to include:

- several exercises and/or data sets requiring use of the skill;
- information about how the skill relates in superordination or subordination to other skills;
- a source list;
- a mnemonic device;
- a graphic organizer.

Revise the skill description incorporating feedback from others. Draft a description of the major attributes of the thinking skill. Use the *Thinking Skill Description* form. Have others check your description for clarity, accuracy and generalizability. Trade your skill description with other teams of teachers to revise each others'. It is ideal if these teachers are working on the same skill. Pool your knowledge.

Rewrite the skill description as appropriate for the grade or experience level of your students. Use the *Thinking Skill Description* form. Use appropriate vocabulary. Make sure there are a manageable number of steps in your procedure. Build on the everyday experiences of your students.

It is important to read descriptions and discussions of our selected thinking skills by other practitioners and by experts in the field. Our textbook includes a detailed source list of thinking skill descriptions as well as several examples. Developing Minds is also another excellent resource for discussions of several thinking skills as well as a bibliography of resources conveniently arranged by academic discipline. Tactics for Thinking describes

several thinking skills. This should also be consulted. Although we might not have time now to incorporate these insights by experts in the field, we should plan to make them a part of our knowledge in the future.

Thinking skills unit planning. Having learned about our selected thinking skills by generating detailed descriptions of them, we are now ready to begin to teach these skills to our students. Common approaches to teaching thinking skills in the content area include the following:

- Stimulate and encourage students to think using thought-provoking questions and subjects of interest to them.
- Foster and facilitate thinking by posing carefully structured and sequenced questions and/or inquiries.
- Exercise students' thinking with appropriate assignments.

Although all of these activities are commendable, it is important to note that none of them teaches students *how* to do what you're asking. Students benefit most from encouragement, facilitation and exercise of their thinking when these are coupled with deliberate, systematic instruction in how to carry out the skill needed to perform the tasks at hand. This is called *direct instruction.* It focuses on the skill as content, especially in the initial stages of instruction, rather than on the subject matter learning generated by use of the skill.

Guiding principles for thinking skill unit planning. Beyer's framework for teaching thinking skills is founded on the following principles of skill learning:

- Thinking skills are not learned as the automatic outcome of instruction that emphasizes subject matter.
- Initial focus must be on the thinking skill, not on the subject matter.
- One lesson is not enough.
- Introduction of each thinking skill should be followed by frequent, intermittent guided practice of the skill.
- To be mastered, a thinking skill should be overlearned at first.
- Student rarely transfer thinking skills beyond the context in which these were learned.
- To foster transfer, apply the thinking skill in a variety of contexts using a wide range of settings.
- Generalizing a skill is learned by executing a variety of tasks, each requiring use of a variety of thinking skills.
- Instruction should take place at a time when students perceive a need for the thinking skill in order to be able to do their work.
- Explicit attention to the thinking skills required to learn course content results in improved grades in the course.

The sequence of the lessons. These principles inform the following framework for teaching thinking skills. The lessons should follow this general sequence:

- Introduction of the skill
- Guided practice in the use of the skill
- Independent application of the skill

- Transfer and/or elaboration of the skill
- Guided practice in the transfer and/or elaboration of the skill
- Independent application of the transferred skill
- Autonomous use of the skill

The lesson types. The lessons in the first three categories are *domain specific:* they would involve content particular to the course in which the thinking skill is being taught. The last three are more general: these lessons reflect how the skill can be used in other contexts, or how it can be further refined.

The *introduction to the skill* is a single lesson 30 to 50 minutes in length, focused on the skill. The course content should not be new material. Course content is secondary to skill content in this lesson. Students should be made aware that the objective of the lesson is the learning of a thinking skill.

The *guided practice* takes place in a sequence of lessons spaced intermittently over several days or weeks as needed. During these lessons, students practice with instructive guidance from the teacher and/or peers. The focus is still on the skill; however, significant course material can be brought into play in this phase. This course material should have the same form of the material used in the introductory lesson. Each guided practice lesson might take about twenty minutes. Guided practice lessons should continue until students reach the level of proficiency desired by the teacher.

For the *independent applications*, the subject matter should be the

the procedure and begins to internalize these. Independent applications should be spaced intermittently over several days or weeks according to need. These need not require any class time. They may be home assignments.

During the *transfer/elaboration* phase, the teacher helps students identify cues that call for the use of a familiar thinking skill in an unfamiliar setting. This phase may also be used to identify subtle changes in the application of a skill in a different context. The thinking skill should now be reintroduced in a new subject matter, in a lesson of about 30 minutes in length.

Guided practice in the new context follows in a sequence of lessons spaced over several days or weeks. As before this is followed by *independent applications.*

Autonomous use of this skill takes place when several thinking skills have been learned and the student must select and apply the appropriate skill(s) when faced with tasks that require their use.

Thinking skills lesson planning. Each type of lesson (introductory, guided practice, transfer/elaboration, etc.) is best taught using particular skill teaching strategies. We will discuss the strategies for introductory lessons first.

Introductory lesson strategies. An introduction to a thinking skill can be taught using an inductive, deductive or developmental strategy.

The inductive strategy. This strategy features a student-directed "discovery" of the attributes of a skill. Field independent students will share

intuitive insights with their more field dependent peers. This provides field independent students the opportunity to become conscious of the workings of their own minds, thus developing the ability to gain more control over their own thought processes.

If unsure of a skill's attributes, the teacher might be able to learn these from the students' perceptions.

Whatever students figure out for themselves is better retained, so this is a good strategy to use with students inclined to discovery. However, students may invent dysfunctional skills and strategies. A commitment to these self-discoveries may inhibit student learning of more effective way to execute a skill.

The directive strategy. Here the teacher derives and explains the skill and its use before the students execute the skill. The teacher presents the key attributes of the thinking skill right at the beginning of the lesson. Although the students may make some discoveries as they apply the procedure, the teacher is very much in control of what is to be learned. Student input is minimized to provide a common base on which students can elaborate with later guidance, practice and reflection.

This approach can minimize confusion. It is useful when teaching time is scarce and/or when a skill is complex. The directive strategy works well with students who have not yet developed a tolerance for ambiguity. Such students would get frustrated by the enormity of the task of defining a thinking skill themselves. These students need to be told what to do.

In practice the inductive strategy provides more opportunity for independent thought than it appears to. Students will often modify the teacher's instruction in the application phase of learning. The directive method can provide a good springboard for original thinking.

The developmental strategy. This strategy combines the experimenting phase of the inductive strategy with the expository phase of the directive strategy. It creates a discrepancy for the students between what they want or need to do and their current ability to do it, and dramatically alerts them to this discrepancy. It then provides the information and guided practice necessary to help them to resolve the discrepancy on a need-to-know basis.

Effective use of this strategy requires that the discrepancy between the desired goal and the current achievement level must not be too large for the students to bridge. Some frustration is desired, but not too much.

Essential features of all skill introduction strategies. Despite their differences, all three introductory thinking skill lesson strategies should be taught with the following important points in mind:

- Be sure the students understand the lesson objective: learning a thinking skill or strategy.

- Spend four to five minutes introducing the skill or strategy, including stating synonyms, examples, and a working definition, if possible.

- Use media and content or subject matter with which students are already familiar, drawn from their own experiences or previously studied. Do <u>not</u> introduce a new skill with new data.

- Keep the application or "doing it" parts of the lesson short--six to eight minutes each, at best.

- Eliminate or at least minimize the interference caused by:
  - other skills or strategies;
  - emotional or value-laden content;
  - subject matter discussion.

- Focus on the major components of the skill or strategy being introduced, especially on *how* the operation is executed and *why.*

- Devote up to one-third of the lesson time to a reflective reporting, discussing and sharing what the students did in their heads to execute the skill.

- In ending the lesson, involve the students in reviewing the key skill procedures, rules and criteria identified so far and, if possible, provide a mnemonic device to assist them in remembering these.

- Help students identify opportunities for using this skill or strategy in their out-of-school activities as well as in their academic work.

Instructional Strategies.

A discussion of you thinking skill descriptions. With seating arranged in a circle, the participants discuss questions concerning their drafts of skill descriptions. The following are some key questions to help focus this discussion:

- What difficulties did you encounter as you generated your thinking skill description?

- In the process of describing your thinking skill, what did you learn about it?

- Was the framework of the *Thinking Skill Description* form suitable for your needs? If not, what adjustments did you make?

- What more you would like to know about your thinking skill?

Refer the participants to lists of resources for further study of their thinking skills.

Thinking skills unit planning. Elicit from the participants what they remember about direct instruction using the following key questions:

- What is direct instruction?
- How does it contrast with what we usually do to make our students think?

A basketball serves as a referent for introducing the guiding principles for thinking skill unit planning. The overhead *Guiding Principles for Thinking Skill Unit Planning* (see Appendix A, 120) is concealed beneath a sheet of paper on the overhead projector. Bounce the ball and point out that thinking skills are like any other skills, such as those associated with a sport. Ask the following questions. As the participants respond to each one, reveal one principle.

- If you want a child to be able to dribble a basketball, do you sit down with him and give him a detailed description of a basketball?
- What do you do?
- Okay, so you show him how to dribble and you have him practice for a few minutes. Does he know how to dribble?
- In fact how long will it take for him to dribble like a pro?
- What more will he need?

The rest of the list is now revealed and discussed specifically in terms of thinking skills.

Describe *the sequence of lessons* using the overhead *A Sequence of Lessons for Teaching a Thinking Skill.* (See Appendix A, 121.)

Introductory lesson strategies. This content is taught using the activity *Double Expert Jigsaw.* (See Appendix B, 141.) Tell the participants that there are three recommended ways to introduce a thinking skill. Teams of three are formed. Each teammate will learn one of these strategies and teach it to the other two team members.

Three packets are distributed to each team. These packets contain:

- a lesson outline for one of three skill teaching strategies (inductive, directive or developmental); (See Appendix A, 122-124.)

- a sample lesson plan that uses that particular strategy to teach the skill of classifying.

After receiving their materials, the teams disband and each member joins his expert group. This is the group that has the same lesson strategy as he does. The expert groups are instructed to help one another master their content.

After this task the experts return to their original teams. Distribute the *Introductory Lesson Strategies Worksheet.* (See Appendix A, 125-126.) The participants take turns teaching their strategies to one another, completing their worksheets in the process.

When all the participants have finished presenting to one another within their teams, the desks are arranged in a circle for a large group discussion of the three strategies. The participants are now instructed to consider these strategies in relationship to their own particular situation. Each should concentrate on his own selected thinking skill, his preferred

teaching style and the ability level of the students who will learn this skill. Each participant in turn then describes which strategy he will use and why.

The participants write their introductory thinking skill lesson as part of their home assignment.

Evaluation.

During the discussion of the thinking skill descriptions, record any questions that require further research. Undertake this research at the end of the session to provide feedback to the participant(s).

Collect copies of the thinking skill descriptions and, after the session, examine the components identified by the participants. Make suggestions for improvement where necessary.

Session Four: Integrating and Evaluating Thinking Skills in the Content Area

Goal.

The goal of the fourth session is to prepare each participant to complete his thinking skills unit plan with lesson plans for guiding practice and facilitating transfer, a calendar for sequencing his thinking skill lessons and an evaluation instrument.

Objectives.

The objectives of the fourth session are as follows:

- The participants will discuss their introductory lesson plans.
- The participants will discuss a strategy for guiding practice in the application of a thinking skill.
- The participants will compare and contrast lesson strategies for the transfer and/or elaboration of a thinking skill with those for the introduction of a thinking skill.
- The participants will preview the use of a calendar for sequencing the lessons in their thinking skills unit.
- The participants will determine ways to evaluate learning of their thinking skills.

Outline.

The fourth session's activities are structured according to the following outline:

I. Your Introductory Lesson

II. Other Lesson Strategies

A. A strategy for guiding practice in your thinking skill

B. Strategies for teaching transfer and/or elaboration of your thinking skill

C. Refining your lesson plans

III. Integrating Your Thinking Skills Lessons with Your Subject Matter Teaching

IV. Evaluating a Thinking Skill

Content.

Other lesson strategies: A strategy for guiding practice in your thinking skill. The strategy used for guiding practice is often referred to by the acronym PREP because its steps are preview, review, execute and ponder. Like the skill introducing strategies, this one:

- keeps the students focused on the skill;
- provides opportunities for the students to articulate the skill's attributes;
- requires application of the skill;

- fosters discussion of what's going on in the students' minds as they practice the skill;
- bridges the skill to other settings.

Independent applications. As noted before, independent applications may not even require any class time. These are the opportunities to think that we have always provided. They can take the form of worksheets, answering textbook questions, answering teacher-asked questions, discovery or inquiry teaching, classroom discussion, debates, writing, challenging assignments, student-asked questions, etc.

Strategies for teaching transfer and/or elaboration of your thinking skill. To elaborate a skill is to introduce a variation that reflects the complexity or subtlety of the skill in changing situations. To transfer a skill means to apply it effectively to new data or in a new setting. "High road" transfer means applying a skill to very different circumstances; "low road" transfer means applying the skill in slightly different circumstances. Neither occurs automatically. Thinking skills need to be applied--with reflection--in a variety of contexts for transfer. Teaching for transfer involves showing students how to apply the skill in other contexts, why it is appropriate to do so and what cues signal the skill's use in the new context.

The lesson for initiating transfer can be taught using inductive, directive or developmental strategies that are similar to their counterparts for skill introduction. The only difference is that a review step is added just after the lesson introduction. By having students complete this review before trying to transfer or elaborate a previously learned skill, a teacher can help

students develop the referents and set needed to facilitate such additional learning.

Strategies for guided practice and independent use of a transferred and/or elaborated skill are the same as with any thinking skill. Autonomous use has the same form as independent use. The difference is that the student selects, from a wide variety of thinking skills, an appropriate thinking skill to apply to a given situation.

Refining your lesson plans. Like all lesson designs, thinking skill lessons need to undergo a process of refinement.

Sequencing thinking skills for the purpose of teaching them in the subject or across subjects. In order to integrate the teaching of our selected thinking skills with our subject matter teaching, it is necessary for each of us to determine where our thinking skill is required in a particular course. We can use the following steps to guide us through that procedure:

- Survey your course for where the thinking skill can be used naturally by students to understand subject matter.
- Fill in the gaps by creating opportunities for additional skill lessons, if needed.
- Translate the skill using opportunities identified into the kind of lesson that is appropriate.
- Repeat these steps for any additional thinking skills to be taught.

Now that you are familiar with the way lessons should be sequenced for teaching thinking skills, it is necessary to apply this framework to a particular course you teach. You want to identify and sequence six to twelve

lessons in your selected thinking skill over one to three months. The use of a calendar similar to the *Thinking Skill Unit Planner* (see Appendix A, 127) might be helpful for this. The first four or five lessons should be close together--about two or three days apart. The remaining lessons should be spaced at increasing intervals. Use your course textbook and/or other resources to identify opportunities for the thinking skill lessons. The first few lessons should be in the same form, familiar to the students and limited in quantity. Double check the spacing of the intervals between lessons. If these are too far apart you may need to insert additional lessons. This sequencing is important and should be done carefully.

After you have identified places where a thinking skill can be taught, determine what type of lesson is appropriate in each place.

Preparing thinking skill assessments. Classroom tests give value to what is being assessed: tests motivate learning. They also reveal where improvement is needed. For the teacher, assessments identify the degree of student learning and how well something was taught. Tests have diagnostic, formative and summative purposes.

Designing and writing thinking skills assessment instruments. The following three principles should guide the preparation of your thinking skill assessments:

- Thinking skills assessment should be continuous throughout the

- Assessing thinking skills begins with four questions:
    - What are you trying to evaluate?
    - What are some useful evaluation techniques?
    - How do you design and manage an evaluation program?
    - How do you use evaluation results?

What are you trying to evaluate? Define your goals for the thinking skill you are teaching. Your thinking skill description is helpful here. Consider also the thinking dispositions necessary to this skill. You will want to evaluate both your student's performance of the thinking skill and the attitudes and beliefs that support it.

What are some useful evaluation techniques? Your choice of evaluation techniques might depend on:

- the type of thinking skill or outcome being measured;
- the number of students being evaluated;
- the time available for evaluation;
- your experience in teaching and evaluating the thinking skill selected;
- how you intend to use the results of the evaluation;
- the availability of evaluation materials.

You will want to select the techniques most appropriate to your goals, as well as those that are most feasible. We will discuss matching goals and techniques more later.

Some useful evaluation techniques are:

- Observing and questioning
  - ° Informal
  - ° Formal (Structured Interview)

- Student self-assessments
  - ° Self-reports
  - ° Inventories

- Holistic scoring
  - ° Analytic scoring
  - ° Focused holistic scoring
  - ° General impression scoring

- Multiple choice tests

- Completion tests

- Open-ended instruments
  - ° Essays
  - ° Journals

How do you design and manage an evaluation program? The organization and management of your program of evaluation requires consideration of these two factors:

- Beliefs about designing an evaluation program;

- Guidelines to assist in making decisions about an evaluation program.

Beliefs about designing an evaluation program:

- Develop your evaluation plan at the same time that you develop your instructional objectives and activities.

- Real growth in thinking skills takes place over a prolonged time. Be realistic in setting your goals. At first, changes in attitudes and beliefs mark progress.

- Students' performance can be influenced by the constraints imposed by the evaluation. Make evaluation as non-threatening as possible. Include a wide variety of evaluation techniques.

• A valid method for assessing students' thinking processes must be included among the assessment instruments.

• A major goal of any thinking skill instruction is the improvement of subject matter learning.

• Among the purposes for evaluation is to have a basis for instructional decisions with respect to the effectiveness of the instruction, the identification of student strengths and weaknesses and assigning grades.

Guidelines to assist in making decisions about an evaluation program:

• Evaluate students' work on a regular, systematic basis.

• Evaluate their thinking processes as well as their answers.

• Match your evaluation plan to your instructional goals.

• Assess attitudes and beliefs as well as performance.

• Observe students' small group efforts as well as their written work.

• Interview students individually or have them keep a journal of their mental processes.

• Do not feel compelled to evaluate every student at the same time.

• Advise students of your evaluation plan and how it works.

How do you use evaluation results? Classroom climate, the content of instruction and teaching methods and the assignment of grades are all proper targets for evaluation results.

Classroom climate. Attitude inventories, student self-reports and student observations can provide feedback on the quality of your classroom atmosphere. If this feedback is negative, consider:

• Content: Are the applications of your thinking skill appropriate with respect to difficulty? Are they interesting and varied? Are they

sequenced to increase in difficulty gradually as your students' confidence increases?

• Time commitment: Is the thinking skill instruction perceived to be a regular and frequent part of your program, or is it considered an "extra"?

• Evaluation practices: Do you evaluate too often? Too seldom? Do you evaluate more than just the answer?

• Your own attitudes, beliefs, methods: Are you enthusiastic? Do you provide students with the kind of help they need, at appropriate times?

Content of instruction and teaching method. Evaluation of data from observations, interviews and analyses of written work can be used to help restructure instruction and teaching methods when needed.

Assigning grades:

• Use a grading system that accounts for the thinking process as well as its products.

• Advise students in advance when their work will be graded.

• Be aware that students may not perform as well as they can in a "test" situation.

• Use all available data as a basis for assigning grades.

• Consider using a testing format that matches your instructional format.

Instructional Strategies.

Your introductory lessons. A brief discussion serves to answer the participants questions.

A strategy for guiding practice in your thinking skill. Distribute and discuss the *Strategy for Guiding Practice in a Thinking Skill.* (See Appendix

A, 128.) Refer to the sample lesson on guiding practice in the skill of classifying (Beyer 1991, C2-C4). Note the features of this lesson type.

Strategies for teaching transfer and/or elaboration of your thinking skill. Distribute the three outlines for *Initiating Transfer.* (See Appendix A, 129-131.) Use the overhead *Transfer Lesson Strategies Worksheet.* (See Appendix A, 132-133.) Compare each of these to its counterpart for skill introduction. How does each differ? Why?

Refining your lesson plans. Discuss the process of refinement for all lesson plans, then ask the participants to relate it to a thinking skill lesson.

Integrating your thinking skills lessons with your subject matter teaching. Demonstrate the use of the *Thinking Skill Unit Planner.*

Evaluating a thinking skill. Form teams of four by academic discipline. Use *Roundtable* (see Appendix B, 142-143) to generate lists of assessment techniques. Discuss the preparation of thinking skill assessments in general. Present examples of thinking skill assessment instruments. (See Appendix A, 100 and 134-135, for two examples.) Discuss each in terms of what it is evaluating, what technique is in use and how its results might be employed. Then the participants use *Think-Pair-Share* to plan the design of one thinking skill assessment instrument.

Completing the unit plans: a summarizing activity. Using *Numbered Heads Together,* each team summarizes one of the objectives for the session. When completed, the summaries are written on the chalkboard by the designated team member and subsequently discussed.

Each summary should focus on one of the following:

- Explain a strategy for guiding practice in the use of your thinking skill.

- Compare one strategy for elaborating or transferring a skill with its counterpart for introducing the skill.

- How do you use a *Thinking Skill Unit Planner*?

- What factors contribute to evaluating a thinking skill?

Evaluation.

To evaluate the success of this session, reflect on the team summaries. Did these adequately express the content presented?

Session Five: Participant Presentations

Goals.

There are two goals for the fifth session. The first is to provide the participants with an opportunity to discuss their progress to date and to receive helpful suggestions for their preparations to teach a thinking skill. The second is to remind the participants that teaching thinking skills is only a part of teaching thinking and to make suggestions for further study.

Objectives.

The objectives for the fifth session are as follows:

- Each participant will present to the class the work he has done to date on his unit plan and explain what he intends to do to complete this project.
- The participants will provide each presenter with written constructive criticisms.
- The participants will discuss the role of teaching thinking skills in relation to teaching thinking in general.
- The participants will receive individualized suggestions for further study.

Outline.

The fifth session's activities are structured according to the following outline:

I. Presenting Your Plans of Action

II. Teaching Thinking Skills as a Part of Teaching Thinking: Suggestions for Further Study

Content.

The participants will provide most of the content for this session. Individualized suggestions for further study will be provided. Raymond Nickerson's description of a good thinker (1987) will be discussed.

Instructional Strategies.

The participants make presentations of the work they have done to date and their plans of action for completing their units. After each presentation, written comments are provided for the presenter by every participant and by the teacher. After all the presentations, distribute individualized lists of resources with suggestions for further study. Reflect on Raymond Nickerson's description of a good thinker.

Evaluation.

Are the participants' unit plans on track?

Did the participants express interest in continuing their studies of thinking?

CHAPTER IV

CLOSING REMARKS

The summer workshop curriculum guides each of the participants through the development of a unit plan for teaching a thinking skill. During the week following the workshop each participant completes his unit plan and presents a copy to the workshop teacher. The teacher reads the unit plans to assess the participants on their learning and to provide suggestions for improvement if necessary.

It is inevitable that questions will arise in the minds of the workshop participants as they complete their unit plans and prepare to teach the unit. The first follow-up session for the workshop is designed to handle those questions.

Just before the academic year begins, the workshop participants meet with the teacher for two and a half hours. This gives the participants the opportunity to discuss questions they might have about implementing their unit plans. It also provides the teacher with the opportunity to share some of the best ideas from the participants' unit plans. Thus the first follow-up session prepares the participants to begin teaching their selected thinking skills.

Approximately one month after the beginning of the academic year, the workshop participants meet again for two and a half hours. The purpose of this meeting is to discuss any problems that have arisen for the participants in the course of implementing their unit plans, and to share ideas about what has been particularly successful. At this session, plans for the future can be launched. The participants are now ready to discuss how to generalize from teaching one thinking skill to layering a second one in the same course, or teaching another in a different course. Plans for these innovations should be implemented gradually, over the next few years, so that each additional unit can be carefully developed.

It is hoped that by the time of the second follow-up session that the workshop participants are enjoying their teaching of a thinking skill and finding that this focus is improving their students' learning. If this is the case, it is likely that they will advance from being able to teach a single thinking skill to being able to teach skillful thinking.

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APPENDIX A

INSTRUCTIONAL MATERIALS

PROBLEM SOLVING WORKSHEET

Name:_____Date:_____

Problem Source:_____Page:_____#_____

Please attach a copy of your problem.

1. Understand the problem.

a. What are you trying to find?

b. What do you know?

2. Devise a plan. (Check the strategies you are using.)

____ write an equation/inequality
____ draw a picture ____ make a table
____ logical reasoning ____ look for a pattern
____ work backwards ____ guess and check
____ use manipulatives____ simulate
____ solve a simpler problem
____ other:
_____

3. Carry out the plan.

4. Examine your solution.

a. Check:

b. Reflect. On the back of this sheet discuss one of the following:

1. Describe your feelings as you worked through this problem.
2. State any principles this problem suggests.
3. Write an original problem based on this one.

Adapted from G. Polya, How to Solve It (Princeton, N. J.: Princeton University Press, 1988).

THINKING SKILL DESCRIPTION

Label: Mathematical Problem Solving

Definition: To arrive at or work out the correct explanation or solution of a mathematical problem.

Synonyms: Find the answer, solve, resolve, prove, demonstrate

Procedure:

1. Understand the problem.
2. Devise a plan.
3. Carry out the plan.
4. Examine your solution.

Rules:

When to use... Use when a problem, or part of a problem, seems to be mathematical in nature.

How to start... Ask yourself, "What do I know?"

What to do if... One strategy isn't working?
Try another.
You are unsure of the answer?
Estimate to see if your solution appears reasonable.

Knowledge or Criteria Used: Translation from a natural language to mathematical language, applicable problem solving strategies, mathematics, formulas, definitions, theorems, postulates.

KEY COMPONENTS OF THINKING

MENTAL OPERATIONS

- **Cognitive**
  - Thinking Strategies
  - Critical Thinking Skills
  - Micro-Thinking Skills
- **Metacognitive**
  - Planning
  - Monitoring
  - Assessing

KNOWLEDGE

- Of general heuristics
- Of the nature of knowledge
- Of the subject matter

DISPOSITIONS

- **Related to thinking in general**
  - Tolerance for ambiguity
  - Respect for evidence
  - Desire to use credible sources
- **Related to specific operations**
  - Preference for considering data before judging
  - Willingness to revise in the light of new evidence
  - Willingness to search for more alternatives

Adapted from Barry Beyer, Practical Strategies for the Teaching of Thinking (Boston: Allyn and Bacon,1987).

Beyer's List of Thinking Skills

I. THINKING STRATEGIES

Problem Solving

1. Recognize a problem
2. Represent the problem
3. Devise/choose solution plan
4. Execute the plan
5. Evaluate the solution

Decision Making

1. Define the goal
2. Identify alternatives
3. Analyze alternatives
4. Rank alternatives
5. Judge highest-ranked alternatives
6. Choose "best" alternative

Conceptualizing

1. Identify examples
2. Identify common attributes
3. Classify attributes
4. Interrelate categories of attributes
5. Identify additional examples/nonexamples
6. Modify concept attributes/structure

II. CRITICAL THINKING SKILLS

1. Distinguish between verifiable facts and values claims
2. Distinguish relevant from irrelevant information, claims or reasons
3. Determine the factual accuracy of a statement
4. Determine the credibility of a source
5. Identify ambiguous claims or arguments
6. Identify unstated assumptions
7. Detect bias
8. Identify logical fallacies
9. Recognize logical inconsistencies in a line of reasoning
10. Determine the strength of an argument or claim

III. MICRO-THINKING SKILLS

Information Processing

1. Recall
2. Comprehend
   a. Translate
   b. Interpret
   c. Extrapolate
3. Apply
4. Analyze
5. Synthesize
6. Evaluate

Reasoning

- Inductive
- Deductive
- Analogous

Adapted from Barry Beyer, Practical Strategies for the Teaching of Thinking (Boston: Allyn and Bacon,1987).

Teaching Thinking Skills in the Content Area: A Workshop for Secondary School Teachers

Participant Information

Name:_____

School:_____

School address:_____

_____

School telephone:_____

Discipline(s) you teach:_____

_____

Courses you presently teach:

Course name	grade	level

Home address:_____

_____

_____

Home telephone:_____

Summer plans:_____

_____

_____

Workshop Syllabus

TEACHING THINKING SKILLS IN THE CONTENT AREA:

A WORKSHOP FOR SECONDARY SCHOOL TEACHERS

Dates:

Teacher:

Office:

Address:

Telephone:

Office hours:

COURSE OUTLINE

Session One: Introduction to the Workshop

I. Welcome

II. Workshop Overview with Expectations

III. The Basics

- A. Why Should We Teach Thinking Skills?
- B. How Can We Teach Thinking Skills Effectively?
- C. Just What Is Thinking Anyway?
  1. A definition of thinking
  2. A model of thinking
  3. A close-up on the thinking skills
- D. Summary of the Basics

IV. Selecting the Thinking Skill You Will Teach

Session Two: Thinking Skill Descriptions

I. Overview

II. Your Selected Thinking Skill

III. General Information about All Thinking Skills

Session Three: Designing and Teaching Thinking Skill Lessons

I. Your Thinking Skill Descriptions

II. Thinking Skills Unit Planning

III. Thinking Skills Lesson Planning

IV. Introductory Lesson Strategies

  A. The inductive strategy

  B. The directive strategy

  C. The developmental strategy

  D. Essential features of all introductory thinking skill lessons

V. Writing Your Introductory Lesson

Session Four: Integrating and Evaluating Thinking Skills in the Content Area

I. Your Introductory Lesson

II. Other Lesson Strategies

  A. A strategy for guiding practice in your thinking skill

  B. Strategies for teaching transfer and/or elaboration of your thinking skill

  C. Refining your lesson plans

III. Integrating Your Thinking Skills Lessons with Your Subject Matter Teaching

IV. Evaluating a Thinking Skill

Session Five: Participant Presentations

I. Presenting Your Plans of Action

II. Teaching Thinking Skills as a Part of Teaching Thinking: Suggestions for Further Study

ASSIGNMENTS

Lesson 1
Read Beyer, pp.1-40: "Preparing to Teach Thinking Skills" and "Identifying Thinking Skill Attributes"

Select a thinking skill to teach. Determine one course where it would be appropriate to teach this thinking skill. Bring to class resources (for that course) that contain data you could use in teaching this skill (such as problems, questions, information).

Lesson 2
Read Beyer, pp. 41-86: "Designing and Teaching Thinking Skill Lessons"

Write a description of a thinking skill that is important in the subject matter you teach. Make a copy of your skill description for your teacher.

Lesson 3
Read Beyer, pp. 87-108: "Preparing Thinking Skill Assesments"

Write an introductory lesson for the thinking skill you previously selected and described. Make a copy for your teacher.

Lesson 4
Read Beyer, pp. 109-130: "Integrating the Teaching of Thinking Skills with Subject Matter"

Create an assessment instrument for your selected thinking skill. Make a copy for your teacher.

Plan your final project and prepare a ten-minute presentation for the class.

FINAL PROJECT
(Due one week after completion of the workshop)

Design a Thinking Skills Unit Plan for a course that you teach. Include:
- A calendar for the sequence of lessons.
- A thinking skill description.
- Three sample thinking skill lessons:
  - One introductory lesson
  - One guided practice lesson
  - One lesson for transfer and/or elaboration
- An evaluation instrument with answer key.

HOW CAN WE TEACH THINKING SKILLS EFFECTIVELY?

What most of us do is provide opportunities to think: we pose challenges that require the higher levels of thought such as comprehension, analysis, synthesis and evaluation.

But what do we do when our students fail to meet these challenges?

To be more effective, when we fail to engage students in the learning we want, we should determine if the failure is due to the students' lack of the necessary thinking skills. If we believe this is the case, then we need to explicitly teach the thinking skills involved in the learning. This means:

- **Temporarily shift the focus of instruction from the subject matter to the thinking skills.**
- **Focus on the key attributes of the thinking skills.**
- **Provide direct instruction and guided practice in these thinking skills in a variety of contexts and for a variety of purposes.**
- **Then provide those opportunities to think.**

This strategy is called the direct method of teaching thinking skills.

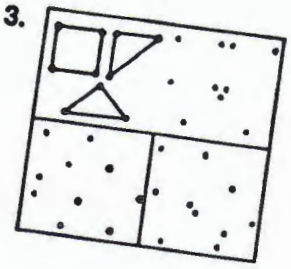
Adapted from Barry Beyer, Practical Strategies for the Teaching of Thinking (Boston: Allyn and Bacon,1987).

THINK !

1. *Mrs. Jones had three children—Peter, Susan and Tamil. She gave each a different task to do. She told one to go to the store, one to sweep the house, and one to clean the garage. Each of the children completed his/her assigned task. Peter did not go to the store. Susan did not clean the garage. Tamil did not clean the garage or sweep the house. Who did what?*

2. In $y = 3x^2 + 5x - 2$
if
$x = 0$ then $y = -2$
so
if $x = 1$ then $y = ?$

3.



4. VOICE OVER P.A.: "Melinda Jones. Come to the office immediately."
STUDENTS IN CLASS: "_____ ? _____."
SAME STUDENTS: "Oh oh. Melinda is in big trouble."

5. GEORGE WASHINGTON IS TO ONE AS ABRAHAM LINCOLN IS TO ___ (five, ten, fifteen, or twenty). ?

Bonus: When explorers discovered Timpali, they found two kinds of people there. The Dindo always lied. All the other natives always told the truth. One day an explorer met three natives. He asked the first if he were Dindo. The first native answered the question. The second native then reported that the first native denied being Dindo. The third native then said that the first native really was Dindo. How many of these natives were Dindo?

6. AN UNTENURED TEACHER AND TWO STUDENTS SAW JOHN SMOKING IN THE SCHOOL LAV. SMOKING IS AGAINST SCHOOL RULES. THE TEACHER IS ALSO THE COACH OF THE BASKETBALL TEAM OF WHICH JOHN IS CAPTAIN. JOHN'S FATHER IS PRESIDENT OF THE BOARD OF EDUCATION AND AN OUTSPOKEN CRITIC OF PERMISSIVE EDUCATION. WHAT SHOULD THE TEACHER DO? WHY?

Adapted from Barry Beyer, Practical Strategies for the Teaching of Thinking (Boston: Allyn and Bacon, 1987).

THINK! AGAIN

Task Number	Answer	What did you do in your head to get this answer?	Describe your feelings about this task.

Adapted from Barry Beyer, Practical Strategies for the Teaching of Thinking (Boston: Allyn and Bacon,1987).

Components of Thinking at Work When We Think

Task Number	Cognitive Operations	Knowledge	Dispositions

Instructions for Writing a Thinking Skill Description

Select a particular thinking skill.

Determine what we need to know about thinking skills in general.

Examine descriptions of the attributes of several thinking skills.

Use a process of reflective analysis to identify the key attributes of the thinking skill selected.

Identify the key attributes of this thinking skill as described by specialists.

Draft a description of the major attributes of the thinking skill.

Revise the skill description incorporating feedback from others.

Rewrite the skill description as appropriate for the grade or experience level of your students.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

Common Characteristics of Thinking Skills

Every thinking skill involves a procedure, rules and knowledge (or criteria).

> The procedure is a series of steps and substeps by which the skill is carried out by those who are proficient in its use. This is what one does mentally when performing the skill.
>
> The rules are principles one follows which inform and guide the execution and application of the procedure.
>
> The knowledge (or criteria) are those applied in carrying out the procedure or following the rules. Knowledge is the set of concepts, heuristics, principles, etc. that are prerequisite to the skill. Criteria are standards or conditions that must be met for something to be judged an example of what it says it is.

There are three reasons why this set of knowledge about a thinking skill is important.

> It keeps students focused on the major attributes of the thinking skill rather than on the application of the thinking skill.
>
> It avoids the danger of irrelevant, dysfunctional and erroneous ideas about the skill.
>
> It helps teachers to prepare assessment instruments for the skill.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

THINKING SKILL DESCRIPTION

Label:

Definition:

Synonyms:

Procedure:

Rules:

When to use...

How to start...

What to do if...

Knowledge or Criteria Used:

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Seccndary School Teachers (Boston: Allyn and Bacon, 1991).

Guidelines for 3-D Reflective Analysis

Do not try to reach a consensus if you and a partner disagree on how a skill should be executed. Identify several different procedures instead.

Be specific as you answer the protocol questions.
Probe deeply. It is not natural to know all you did as you worked. The mind operates rapidly, and a great deal of probing is necessary to determine what is going on when you think.

Concentrate initially on identifying the major steps of a skill and obvious rules and knowledge. You do not need to find something for each category, nor to include everything you and your partner identify.

Avoid idiosyncrasies.

Focus on the thinking skill rather than on the data. Concentrate on what you did and why.

Be sure your procedure is identifying how to carry out the skill, not just saying, "Do it."

Rules often take repeated performances to identify. Examine what problems and obstacles arose as you worked and your resolution of these. Consider when you would use the skill and why. Ask yourself what procedure might precede or follow this skill. Is it one step in other major thinking tasks?

Generalize, if possible, beyond the immediate task. Use your skill on several different types of data to help do this.

Remain tentative. Your description is based on limited knowledge. Be open to alternatives, refinements and clarifications. Change your description to include these.

The more times you use the 3-D Reflective Analysis procedure, the better your skill description will be.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

Guiding Principles for Thinking Skill Unit Planning

Thinking skills are not learned as the automatic outcome of instruction that emphasizes subject matter.

Initial focus must be on the thinking skill, not on the subject matter.

One lesson is not enough.

Introduction of each thinking skill should be followed by frequent, intermittent guided practice of the skill.

To be mastered, a thinking skill should be overlearned at first.

Students rarely transfer thinking skills beyond the context in which these were learned.

To foster transfer, apply the thinking skill in a variety of contexts using a wide range of settings.

Generalizing a skill is learned by executing a variety of tasks, each requiring use of a variety of thinking skills.

Instruction should take place at a time when students perceive a need for the thinking skill in order to be able to do their work.

Explicit attention to the thinking skills required to learn course content results in improved grades in the course.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

A Sequence of Lessons for Teaching a Thinking Skill

Introduction of the skill

Guided practice in the use of the skill

Independent application of the skill

Transfer and/or elaboration of the skill

Guided practice in the transfer and/or elaboration of the skill

Independent application of the transferred skill

Autonomous use of the skill

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INTRODUCING A THINKING SKILL: AN INDUCTIVE STRATEGY

STEP 1 *PREVIEW THE SKILL*

State that "learning" the skill is today's objective.
Give the skill label/name.
Give synonyms.
State a tentative/working definition.
State ways the skill can be or has been used:
- in students' personal experiences,
- in school activities,
- in this course.

Explain how the skill is useful and why it's worth learning.

STEP 2 *EXECUTE THE SKILL*

Use the skill (as best one can) to accomplish a task.
Work in pairs, triads, or groups.
Use subject matter familiar to students and appropriate to course (or if necessary, from students' experience).

STEP 3 *REFLECT ON WHAT WAS DONE*

Students report what went on in their heads as they engaged in the skill.
Identify the key steps/rules used and sequence of each.
Clarify the procedure and any criteria used.
Focus on the skill and its attributes.

STEP 4 *APPLY SKILL TO NEW DATA*

Use what has been discussed about the skill to complete a second task.
Work in pairs, triads, or groups.
Use subject matter appropriate to the course but in the same structure and media as in Step 2.

STEP 5 *REVIEW THE SKILL*

Report on what students did in their heads as they applied the skill.
Review the steps/procedure that seem to constitute the skill.
Review the rules that direct use of the skill as well as when it is to be used.
State the relationship of this skill to other skills.
Review or revise the skill definition.
State where the skill can be used in personal or out-of-school situations.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INTRODUCING A THINKING SKILL: A DIRECTIVE STRATEGY

STEP 1 *PREVIEW THE SKILL*

State that "learning" the skill is today's objective.
Give the skill label/name.
Give synonyms.
State a tentative/working definition.
State ways the skill can be or has been used:
- in students' personal experience,
- in school activities,
- in this course.

Explain how the skill is useful and why it's worth learning.

STEP 2 *EXPLAIN THE SKILL*

State the procedure constituting the skill in step-by-step sequence, explaining what one does and why for each step.
State key rules and "things to know" about the skill.

STEP 3 *DEMONSTRATE THE SKILL*

Lead the class step-by-step through the skill:
- state the goal,
- refer to each step in the procedure,
- give reasons for doing each step.

Show how rules are carried out.
Use course subject matter familiar to the students (or, if necessary, from their experience).

STEP 4 *REVIEW WHAT WAS DONE*

Review the procedures and rules.
Review the reasons for each (as illustrated in the demonstration).

STEP 5 *APPLY THE SKILL*

Execute the skill with teacher guidance.
Work in pairs, triads, or groups.
Complete material used in demonstration or use new but same kind of data/media as used in Step 3.

STEP 6 *REFLECT ON THE SKILL*

Review the steps comprising the skill and the rules guiding its use.
Reflect on ways in which the skill is used and when it is appropriate to use.
State the relationship of this skill to other skills.
Review or revise skill definition..
State where the skill can be used in
- personal or out-of-school situations,
- coursework.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INTRODUCING A THINKING SKILL: A DEVELOPMENTAL STRATEGY

STEP 1 *PREVIEW THE SKILL*

State that "learning" the skill is today's objective.
Give the skill label/name.
Give synonyms.
State a tentative/working definition.
State ways the skill can be or has been used:

- in students' personal experience,
- in school activities,
- in this course.

Explain how the skill is useful and why it's worth learning.

STEP 2 *EXECUTE THE SKILL*

Use the skill (as best one can) to accomplish a task.
Work in pairs, triads, or groups.
Use subject matter familiar to the students and appropriate to course or from students' experience.

STEP 3 *REFLECT ON WHAT WAS DONE*

Report what went on in students' heads as they engaged in the skill.
Identify the steps and rules used and their sequence.
Clarify procedures or any criteria used.
Focus on the skill and its attributes.

STEP 4 *EXPLAIN/DEMONSTRATE*

State any key operations or key rules omitted or misapplied by students.
Give reasons for using these procedures or rules.
Demonstrate application of these operations or rules, explaining how and why each is used.

STEP 5 *APPLY THE SKILL TO NEW DATA*

Use the teacher-introduced procedures and rules with student descriptions of the skill to complete original or another task.
Students work in pairs or groups.
Use subject matter familiar to the students and appropriate to course, but in the same structure and media like that used in Step 2.

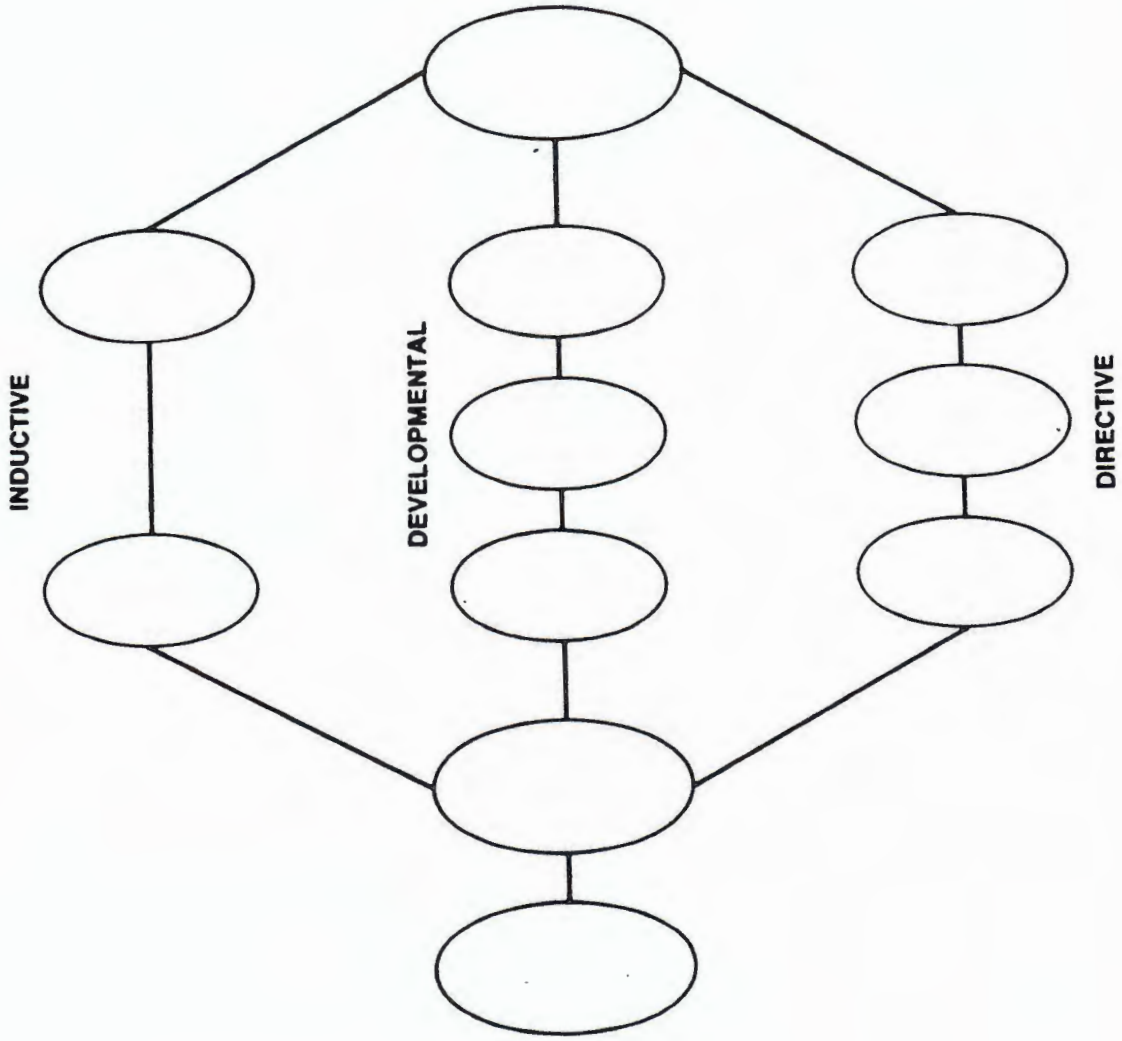
STEP 6 *REVIEW THE SKILL*

Report on what was done in students' heads as they applied the skill.
Review the procedures and rules that seem to constitute the skill.
State the relationship of this skill to other skills.
Review or revise the skill definition.
State where the skill can be used in:

- personal or out-of-school situations,
- coursework.

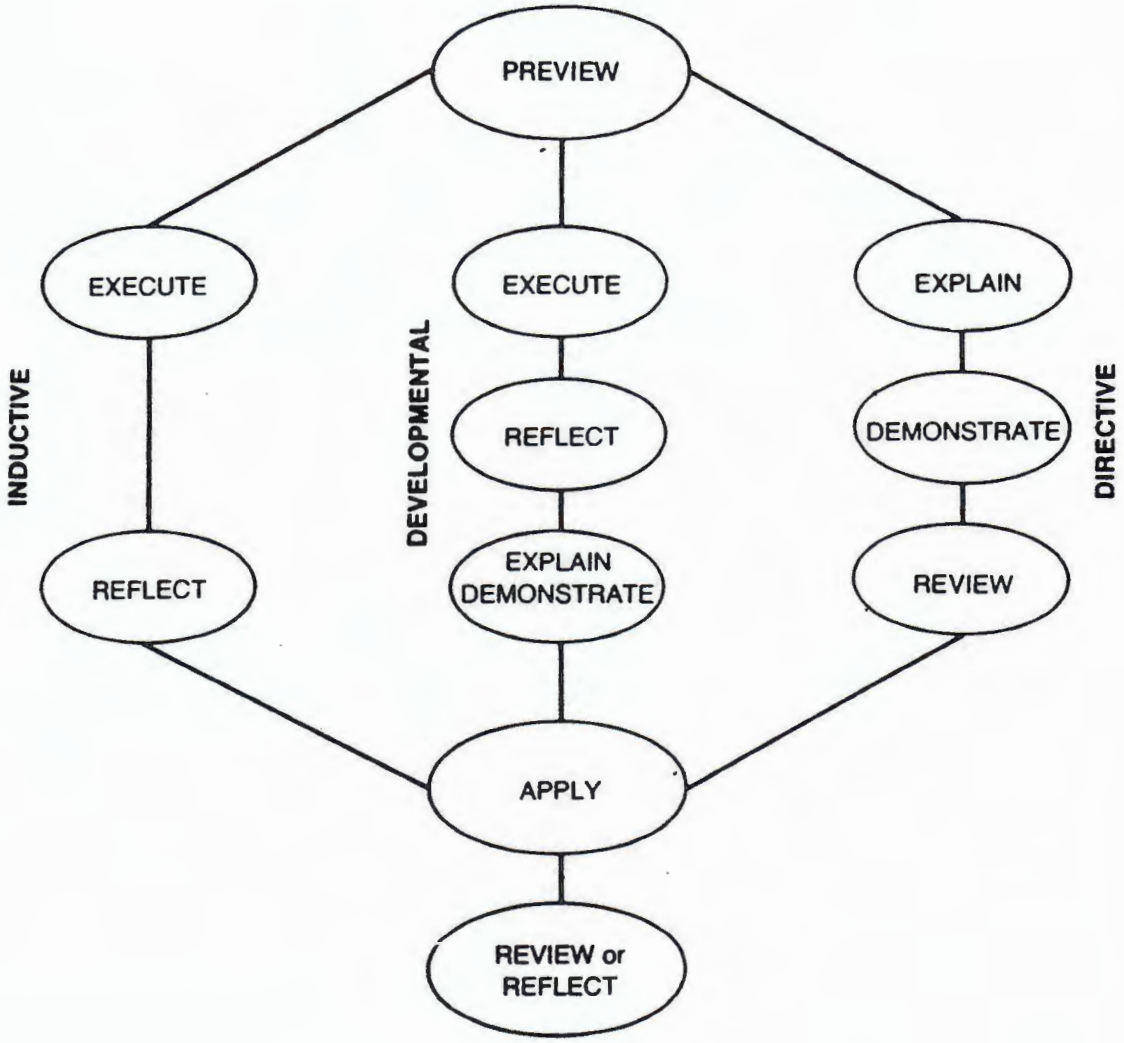
Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INTRODUCTORY LESSON STRATEGIES WORKSHEET



Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INTRODUCTORY LESSON STRATEGIES



Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

THINKING SKILLS UNIT PLANNER

LESSON:	1	2	3	4	5	6	7
focus on the thinking skill			✓ Introduction		✓ Guided Practice		✓ Guided Practice
LESSON:	8	9	10	11	12	13	14
focus on the thinking skill		✓ Guided Practice		✓ Guided Practice			✓ Guided Practice
LESSON:	15	16	17	18	19	20	21
focus on the thinking skill		✓ Independent Use		✗ Independent Use			✓ Transfer or Elaboration
LESSON:	22	23	24	25	26	27	28
focus on the thinking skill	✓ Guided Practice		✓ Guided Practice			✓ Autonomous Use	

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

STRATEGY FOR GUIDING PRACTICE IN A THINKING SKILL

STEP 1 *PREVIEW THE SKILL*

Remind the students that learning the skill is an objective of the course and lesson.

Help the students recall

- the skill label,
- synonyms,
- a simple definition,
- examples of where the skill has already been used.

Discuss the value of the skill.

Point out how use of the skill is helpful here.

STEP 2 *REVIEW THE SKILL*

Help the students identify key

- rules that direct the skill,
- steps in how the skill works,
- useful information about the skill.

Clarify any obstacles they may anticipate and how to overcome them.

Clarify how to start doing the skill.

STEP 3 *EXECUTE THE SKILL AND MONITOR*

Have students engage in the skill with reference to what they discussed about it.

Each may work with a partner who checks the executing of the skill.

Teacher provides help as needed.

STEP 4 *PONDER (REFLECT ON) THE SKILL*

Help the students identify the key attributes of the skill, including its

- rules,
- procedure,
- associated knowledge.

Have the students

- predict where else this skill can be used,
- predict other skills with which this skill can be used,
- identify cues to occasions when it is appropriate to use this skill.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INITIATING TRANSFER OF A THINKING SKILL: AN INDUCTIVE STRATEGY

STEP 1 *PREVIEW THE SKILL*

State that "learning" the skill is today's objective.
Give the skill label/name.
Give synonyms.
State a tentative/working definition..
State ways the skill can be or has been used:

- in students' personal experiences,
- in school activities,
- in this course.

Explain how the skill is useful and why it's worth learning.

STEP 2 *REVIEW THE SKILL*

Students recall attributes of the skill as learned thus far:

- operations,
- rules used,
- useful information about the skill.

Students describe how to execute the skill.
Students identify potential obstacles to smooth operation of the skill and ways to resolve the obstacles.

STEP 3 *EXECUTE THE SKILL—DO IT*

Use the skill (as best one can) to accomplish a task.
Work in pairs, in triads, or groups.
Use subject matter familiar to the students and appropriate to the course (or, if necessary, from students' experience).

STEP 4 *REFLECT ON WHAT WAS DONE*

Report what went on in students' heads as they engaged in the skill.
Identify the steps/rules used and sequence of each.
Clarify the procedure or any criteria used.
Focus on the skill and its attributes.

STEP 5 *APPLY SKILL TO NEW DATA*

Use what has been discussed about the skill to complete a second task.
Work in pairs, triads, or groups.
Use subject matter appropriate to the course and familiar to the students and in same structure and media as in Step 3.

STEP 6 *REVIEW THE SKILL*

Report on what students did in their heads as they applied the skill.
Review the steps/procedures that seem to constitute the skill.
Review the rules that direct use of the skill as well as when it is to be used.
State the relationship of this skill to other skills.
Review or revise the skill definition.
State where the skill can be used in personal or out-of-school situations.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INITIATING TRANSFER OF A THINKING SKILL: A DIRECTIVE STRATEGY

STEP 1 *PREVIEW THE SKILL*

State that "learning" the skill is today's objective.
Give the skill label/name.
Give synonyms.
State a tentative/working definition.
State ways the skill can be or has been used:

- in students' personal experience,
- in school activities,
- in this course.

Explain how the skill is useful and why it's worth learning.

STEP 2 *REVIEW THE SKILL*

Students recall attributes of the skill as learned thus far:

- operations,
- rules used,
- useful information about the skill.

Students describe how to execute the skill.
Students identify potential obstacles to smooth operation of the skill and ways to resolve the obstacles.

STEP 3 *EXPLAIN THE SKILL*

State any new procedures constituting the skill in step-by-step sequence, explaining what one does and why for each step.
State new rules and "things to know" about the skill.

STEP 4 *DEMONSTRATE THE SKILL*

Lead the class step-by-step through the skill:

- state the goal,
- refer to each step in the procedure,
- give reasons for doing each step.

Show how the rules are carried out.
Use subject matter familiar to the students.

STEP 5 *REVIEW WHAT WAS DONE*

Review the procedures and rules.
Review the reasons for each (as illustrated in the demonstration).

STEP 6 *APPLY THE SKILL*

Execute the skill with teacher guidance.
Work in pairs, triads, or groups.
Complete material used in demonstration or use new but same kind of data/media.
Use course subject matter familiar to students but in same structure and media as in Step 4.

STEP 7 *REFLECT ON THE SKILL*

Review the steps comprising the skill and the rules guiding its use.
Reflect on ways in which the skill is used and when it is appropriate to use.
State the relationship of this skill to other skills.
Review or revise skill definition.
State where the skill can be used in:

- personal or out-of-school situations,
- coursework.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

INITIATING TRANSFER OF A THINKING SKILL: A DEVELOPMENTAL STRATEGY

STEP 1 *PREVIEW THE SKILL*

State that "learning" the skill is today's objective.
Give the skill label/name.
Give synonyms.
State a tentative/working definition.
State ways the skill can be or has been used:

- in students' personal experience,
- in school activities,
- in this course.

Explain how the skill is useful and why it's worth learning.

STEP 2 *REVIEW THE SKILL*

Students recall attributes of the skill as learned thus far:

- operations,
- rules used,
- useful information about the skill.

Students describe how to execute the skill.
Students identify potential obstacles to smooth operation of the skill and ways to resolve the obstacles.

STEP 3 *EXECUTE THE SKILL—DO IT*

Use the skill (as best one can) to accomplish a task.
Work in pairs or in groups.
Use subject matter appropriate to course and familiar to the students.

STEP 4 *REFLECT ON WHAT WAS DONE*

Report what went on in students' heads as they engaged in the skill.
Identify the steps and rules used and their sequence.
Clarify operations or any criteria used.
Focus on the skill and its attributes.

STEP 5 *EXPLAIN/DEMONSTRATE*

State any key operations or key rules omitted or misapplied by students.
Give reasons for using these operations or rules.
Demonstrate application of these operations or rules, explaining how and why each is used.

STEP 6 *APPLY THE SKILL TO NEW DATA*

Use the teacher-introduced operations and rules with student descriptions of the skill to complete another task.
Students work in pairs or groups.
Use subject matter familiar to the students and appropriate to course but in same structure and media as in Step 3.

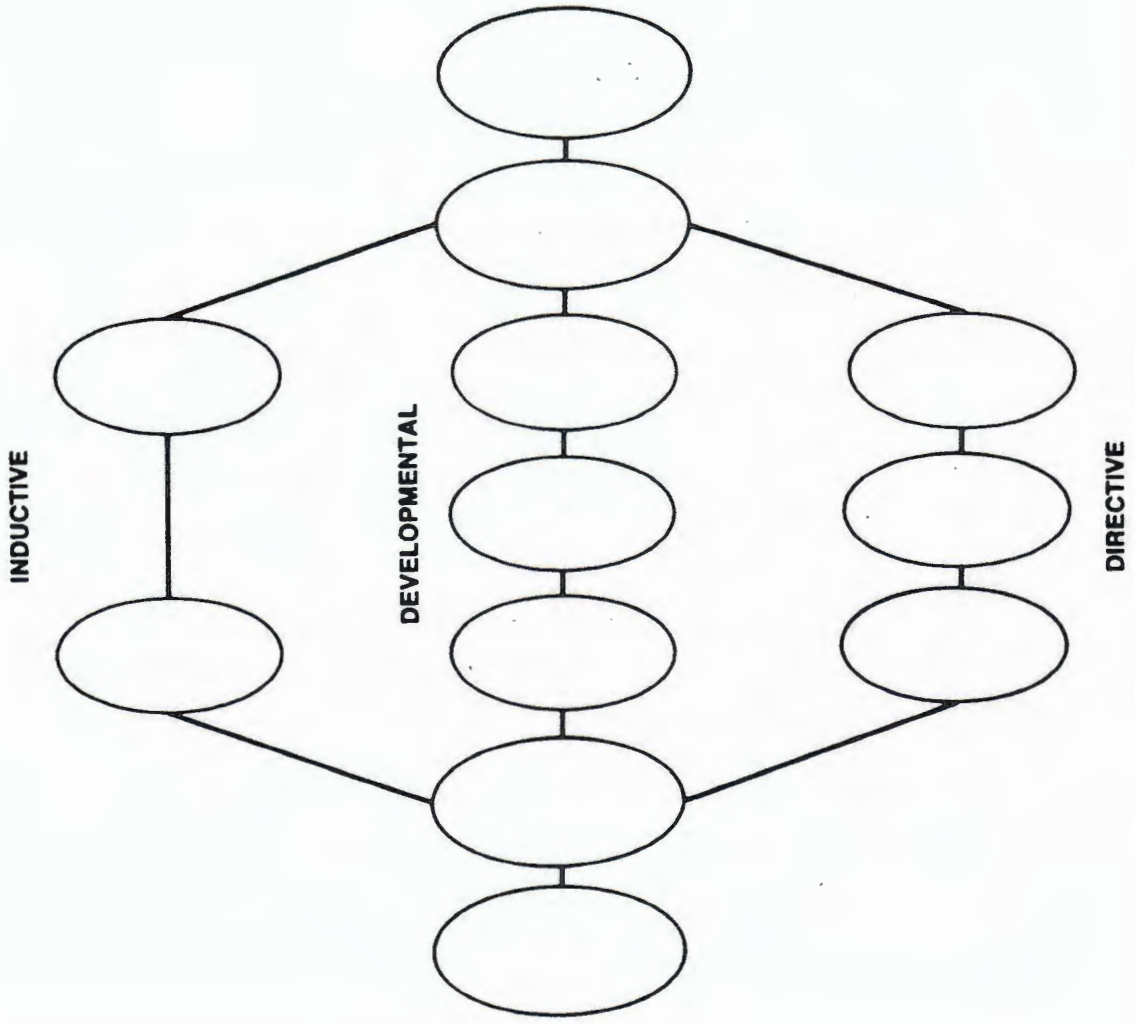
STEP 7 *REVIEW THE SKILL*

Report on what was done in students' heads as they applied the skill.
Review the operations and rules that seem to constitute the skill.
State the relationship of this skill to other skills.
Review or revise the skill definition.
State where the skill can be used in

- personal or out-of-school situations,
- coursework.

Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

TRANSFER LESSON STRATEGIES WORKSHEET



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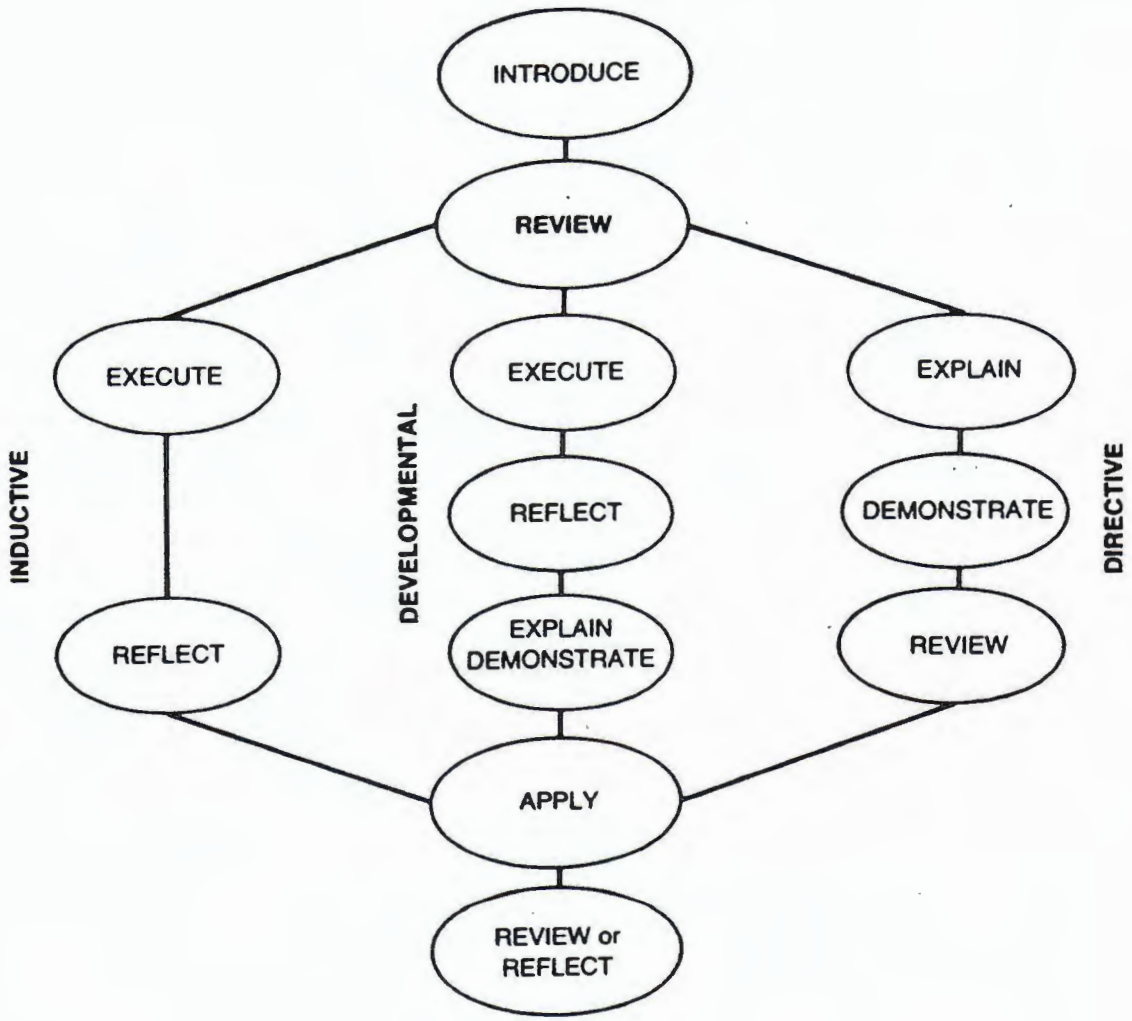
TRANSFER LESSON STRATEGIES



Adapted from Barry Beyer, Teaching Thinking Skills: A Handbook for Secondary School Teachers (Boston: Allyn and Bacon, 1991).

Name:_____Date:_____

PROBLEM SOLVING ATTITUDE INVENTORY

The following questions refer to how you feel about solving math problems. Please mark **true** or **false** depending on how the statement relates to you.

_____ 1. I will put down any answer just to finish a problem.

_____ 2. It is no fun trying to solve problems.

_____ 3. I will try almost any problem.

_____ 4. When I do not get the right answer right away I give up.

_____ 5. I like to try hard problems.

_____ 6. My ideas about solving problems are not as good as other students' ideas.

_____ 7. I can only do problems everyone else can do.

_____ 8. I will not stop working on a problem until I get an answer.

_____ 9. I am sure I can solve most problems.

_____ 10. I will work a long time on a problem.

_____ 11. I am better at solving problems than many students.

_____ 12. I need someone to help me work on problems.

_____ 13. I can solve most hard problems.

_____ 14. There are some problems I will just not try.

_____ 15. I do not like to try problems that are hard to understand.

_____ 16. I will keep working on a problem until I get it right.

_____ 17. I like to try to solve problems.

_____ 18. I give up on problems right away.

_____ 19. Most problems are too hard for me to solve.

_____ 20. I am a good problem solver.

Adapted from an inventory developed for the Mathematical Problem Solving Project at Indiana State University.

Using the **PROBLEM SOLVING ATTITUDE INVENTORY**

The three categories assessed by the items in this inventory are willingness to engage in problem solving activities (items 2, 3, 5, 14, 15, 17), perseverance during the problem solving process (items 1, 4, 8, 10, 16, 18) and self-confidence with respect to problem solving (items 6, 7, 9, 11, 12, 13, 19, 20). Items are worded to reveal positive or negative feelings as follows: positive--items 3, 5, 8-11, 13, 16, 17, 20; negative--items 1, 2, 4, 6, 7, 12, 14, 15, 18, 19.

For each negatively worded item, assign "0" if marked true and "1" if marked false. For each positively worded item, assign "0" if marked false and 1 if marked true.

APPENDIX B

COOPERATIVE LEARNING STRUCTURES

FIND YOUR MATCH

Description of the structure

This structure is for use with lists of information whose items can be split into two corresponding pieces. The procedure for this structure is as follows.

1. Distribute the corresponding pieces of the list items randomly among the students so that each student receives one piece of information.
2. Upon a signal each student searches for the person who has the piece of information that corresponds to his own.
3. When they find one another, the students combine their information and sit down together.

Some uses of the structure

Building of class spirit
Forming of teams of two
Promoting interaction among strangers
Practice of communications skills
Mastery of content

Some features of the structure

Simultaneous interaction
Positive interdependence

Adapted from Spencer Kagan, Cooperative Learning (San Juan Capistrano, CA: Kagan Cooperative Learning, 1992).

THREE STEP INTERVIEW

Description of the structure

Students work in pairs. This structure proceeds according to the following steps.

1. One student interviews the other.
2. The roles are reversed.
3. Each student reports the results of his interview to the class.

Some uses of the structure

Building of class spirit
Practice of communication skills
Information sharing
Mastery of content
Summary of lesson

Some features of the structure

Simultaneous interaction
Positive interdependence
Individual accountability

Adapted from Spencer Kagan, Cooperative Learning (San Juan Capistrano, CA: Kagan Cooperative Learning, 1992).

THINK-PAIR-SHARE

Description of the structure

Students work in pairs. This structure proceeds according to the following steps.

1. A problem is posed.
2. Silent think time is provided.
3. Pairs discuss their ideas together.
4. These ideas are shared with the class.

Some uses of the structure

Create anticipatory set
Summary of lesson
Problem-solving
Decision-making
Mastery of content

Some features of the structure

Simultaneous interaction
Peer tutoring

Adapted from Spencer Kagan, Cooperative Learning (San Juan Capistrano, CA: Kagan Cooperative Learning, 1992).

NUMBERED HEADS TOGETHER

Description of the structure

Students work in teams of three, four or five (preferably four). The roles active in this structure are:

1) the Quiet Captain who raps his knuckles on the desk to quietly remind his team members to lower their voices;
2) the Gate-Keeper who makes sure everyone on the team contributes to the discussion in turn.

To begin the activity, students number off (or have a pre-assigned number). The teacher poses a challenge. Through discussion, each team member makes sure everyone on the team can meet the challenge in an appropriate, specified time limit. When time is up, the teacher calls a number. The person from each team with that number records the team solution on the chalkboard or on paper.

Some uses of the structure

Mastery of content
Summary of lesson
Comparison of problem-solving techniques

Some features of the structure

Simultaneous interaction
Role responsibility
Individual accountability
Peer tutoring
Good mastery technique

Adapted from Spencer Kagan, Cooperative Learning (San Juan Capistrano, CA: Kagan Cooperative Learning, 1992).

DOUBLE EXPERT JIGSAW

Description of the structure

This structure proceeds according to the following steps.
1. Subdivide the learning unit into topics (preferably four).
2. Form "home teams" with the same number of members as there are topics.
3. For each home team assign a different topic to each member.
4. Form "expert groups". Each expert group shares the same topic. Each expert group thus has one member from each home team.
5. The expert groups consult to master their topic.
6. Each expert returns to his home team.
7. In turn, each expert teaches his topic to his home team.
8. Together the team completes an assignment on the unit.
9. Individually the students are assessed on the unit.

Some uses of the structure

Content mastery
Practice of communication skills
Information sharing

Some features of the structure

Simultaneous interaction
Positive interdependence
Peer tutoring
Time-saving

Adapted from Spencer Kagan, Cooperative Learning (San Juan Capistrano, CA: Kagan Cooperative Learning, 1992).

ROUND TABLE

Description of the structure

Students work in teams of three, four or five (preferably four). Each student has a role with particular responsibilities. Only one or two roles would be active in this structure. The Materials Monitor is responsible for obtaining and returning materials for the team, rearranging furniture and cleaning up after the activity, if necessary. The Reporter reports team findings to the class.

To begin the activity, students number off (or have a pre-assigned number). The teacher then names a topic. Starting with person #1, a sheet of paper goes around the table. (Hence the structure's name.) Each student in turn writes his number and one word, phrase or sentence that he associates with the topic. The paper may circulate two or three times. The reporter for each group then reads (or writes on the chalkboard) the team's contributions.

Some uses of the structure

Create anticipatory set
Check for content acquisition
Liven up drill and practice

Some features of the structure

Simultaneous interaction
Individual accountability
Quiet, orderly
Not time-consuming

Adapted from Spencer Kagan, Cooperative Learning (San Juan Capistrano, CA: Kagan Cooperative Learning, 1992).

ROUND TABLE WORKSHEET

Team members:_____(1)
_____(2)
_____(3)
_____(4)
_____(5)

Topic:_____
Instructions: Please print your response next to your number.

1.

2.

3.

4.

5.

1.

2.

3.

4.

5.